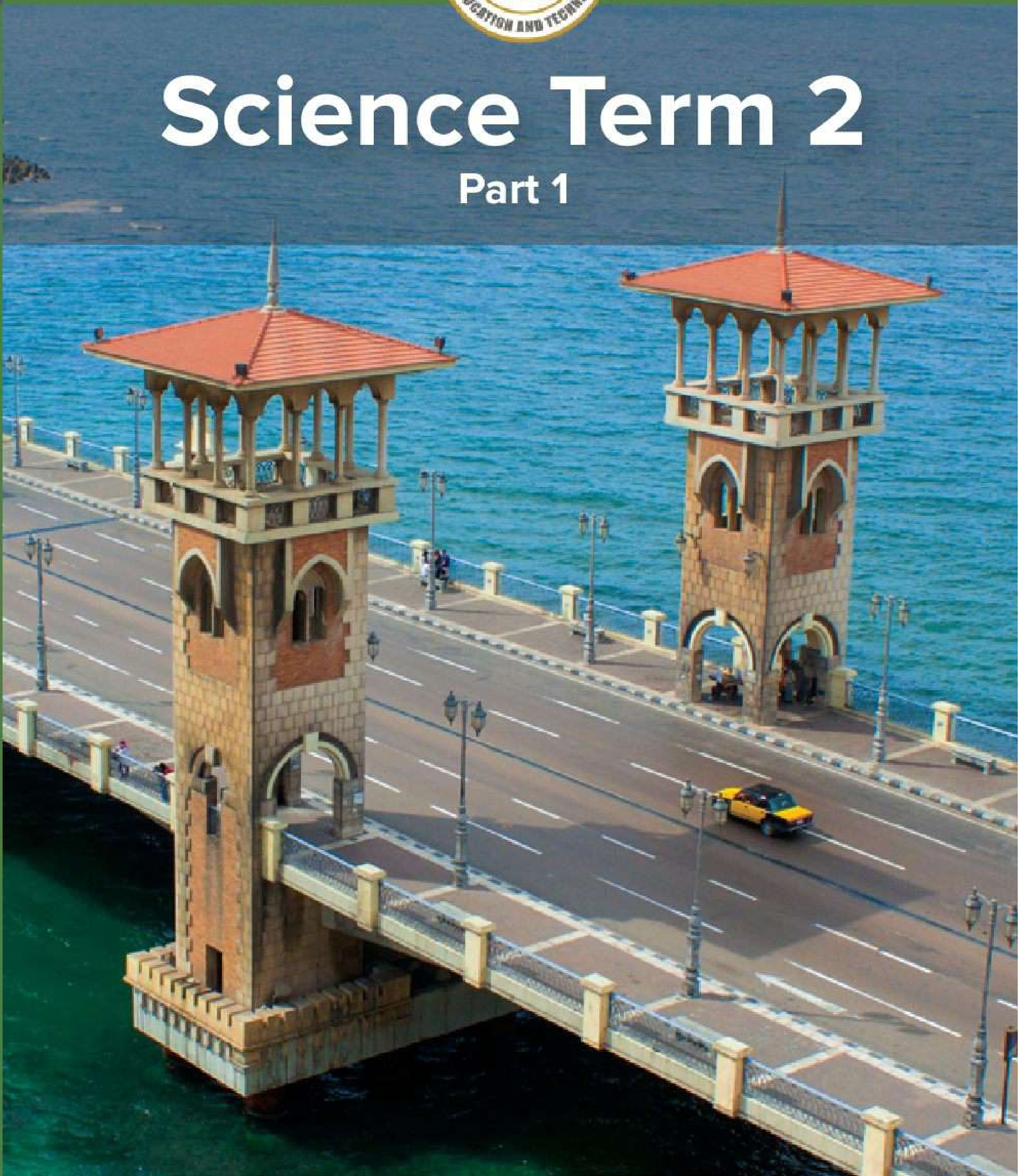
Primary 4
Student Edition
Unit 3

Science Term 2

Part 1

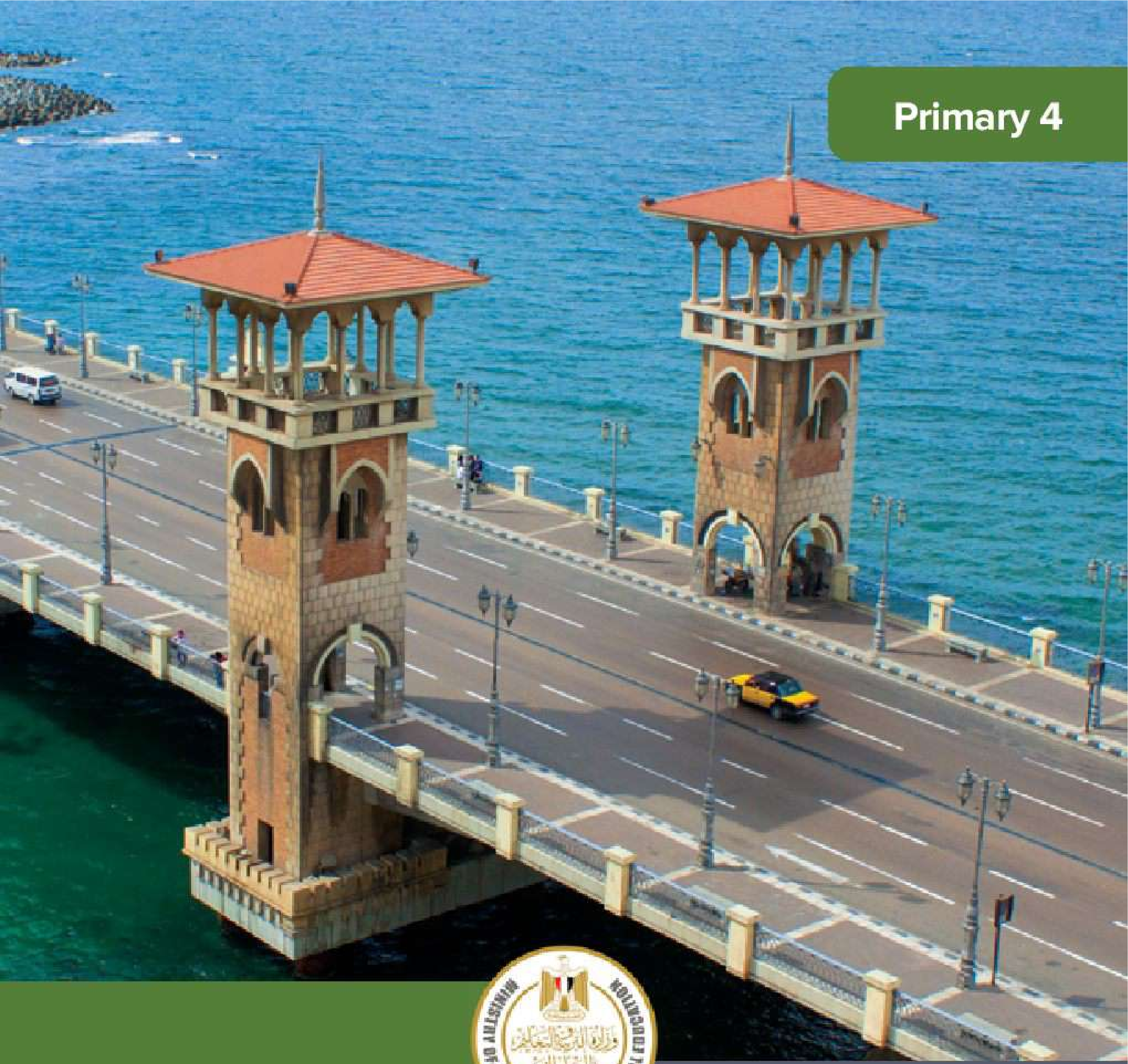


Primary 4
Science Term 2 • Part 1

Primary 4 Science

Name ____

Primary 4



MINISTRY OF EDUCATION AND TECHNICAL EDUCATION

Science Term 2

Part 1

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FOREWORD

This is a pivotal time in the history of the Ministry of Education and Technical Education (MOETE) in Egypt. We are embarking on the transformation of Egypt's K-12 education system. We started in September 2018 with the rollout of KG1, KG2 and Primary 1. In 2021 we have rolled out Primary 4, and we will continue with the rollout until 2030. We are transforming the way in which students learn to prepare Egypt's youth to succeed in a future world that we cannot entirely imagine.

MOETE is very proud to present this new series of textbooks, with the accompanying digital learning materials that captures its vision of the transformation journey. This is the result of much consultation, much thought and a lot of work. We have drawn on the best expertise and experience from national and international organizations and education professionals to support us in translating our vision into an innovative national curriculum framework and exciting and inspiring print and digital learning materials.

The MOETE extends its deep appreciation to its own "Center for Curriculum and Instructional Materials Development" (CCIMD) and specifically, the CCIMD Director and her amazing team. MOETE is also very grateful to the minister's senior advisors and to our partners including "Discovery Education," "National Geographic Learning" "Nahdet Masr," "Longman Egypt," UNICEF, UNESCO, and WB, who, collectively, supported the development of Egypt's national curriculum framework. I also thank the Egyptian Faculty of Education professors who participated in reviewing the national curriculum framework. Finally, I thank each and every MOETE administrator in all MOETE sectors as well as the MOETE subject counselors who participated in the process.

This transformation of Egypt's education system would not have been possible without the significant support of Egypt's current president, His Excellency President Abdel Fattah el-Sisi. Overhauling the education system is part of the president's vision of "rebuilding the Egyptian citizen" and it is closely coordinated with the ministries of Higher Education & Scientific Research, Culture, and Youth & Sports. Education 2.0 is only a part in a bigger national effort to propel Egypt to the ranks of developed countries and to ensure a great future to all of its citizens.

WORDS FROM THE MINISTER OF EDUCATION & TECHNICAL EDUCATION

It is my great pleasure to celebrate this extraordinary moment in the history of Egypt where we continue to launch a new education system designed to prepare a new Egyptian citizen proud of his Egyptian, Arab and African roots — a new citizen who is innovative, a critical thinker, able to understand and accept differences, competent in knowledge and life skills, able to learn for life and able to compete globally.

Egypt chose to invest in its new generations through building a transformative and modern education system consistent with international quality benchmarks. The new education system is designed to help our children and grandchildren enjoy a better future and to propel Egypt to the ranks of advanced countries in the near future.

The fulfillment of the Egyptian dream of transformation is indeed a joint responsibility among all of us; governmental institutions, parents, civil society, private sector and media. Here, I would like to acknowledge the critical role of our beloved teachers who are the role models for our children and who are the cornerstone of the intended transformation.

I ask everyone of us to join hands towards this noble goal of transforming Egypt through education in order to restore Egyptian excellence, leadership and great civilization.

My warmest regards to our children who will begin this journey and my deepest respect and gratitude to our great teachers.

Dr. Tarek Galal Shawki

Minister of Education & Technical Education

Dear Parent/Guardian,

This year, your student will be using Science Techbook™, a comprehensive science program developed to inspire students to act and think like scientists and engineers. Throughout the year, students will ask questions about the world around them and solve real-world problems through the application of critical thinking across the domains of science (Life Science, Earth and Space Science, Physical Science, Environmental Science, and Engineering).

Science Techbook is an innovative program that helps your student master key scientific concepts. Students engage with interactive science materials to analyze and interpret data, think critically, solve problems, and make connections across science disciplines. Science Techbook includes dynamic content, videos, digital tools, hands-on investigations and labs, and game-like activities that inspire and motivate scientific learning and curiosity.

Science Techbook is divided into units, and each unit is divided into concepts. Each concept has three sections: Wonder, Learn, and Share.

Units and Concepts Students begin to consider the connections across fields of science to understand, analyze, and describe real-world phenomena.

Wonder Students activate their curiosity and prior knowledge of a concept's essential ideas and begin making connections to a real-world situation.

Learn Students dive deeper into core scientific concepts through critical reading of texts and analysis of multimedia resources. Students also build their learning through investigations and interactives focused on the learning goals.

Share Students share what they are learning with their teacher and classmates using evidence they have gathered and analyzed during Learn. Students connect their learning with entrepreneurship, careers, and problem-solving skills.

Within this Student Edition, you will find QR codes and quick codes that take you and your student to a corresponding section of Science Techbook online.

We encourage you to support your student in using the print and online interactive materials in Science Techbook, on any device. Together, may you and your student enjoy a fantastic year of science and exploration.

Sincerely,

The Science Team

Theme 3 | Protecting Our Planet

Unit 3
Energy and Fuels

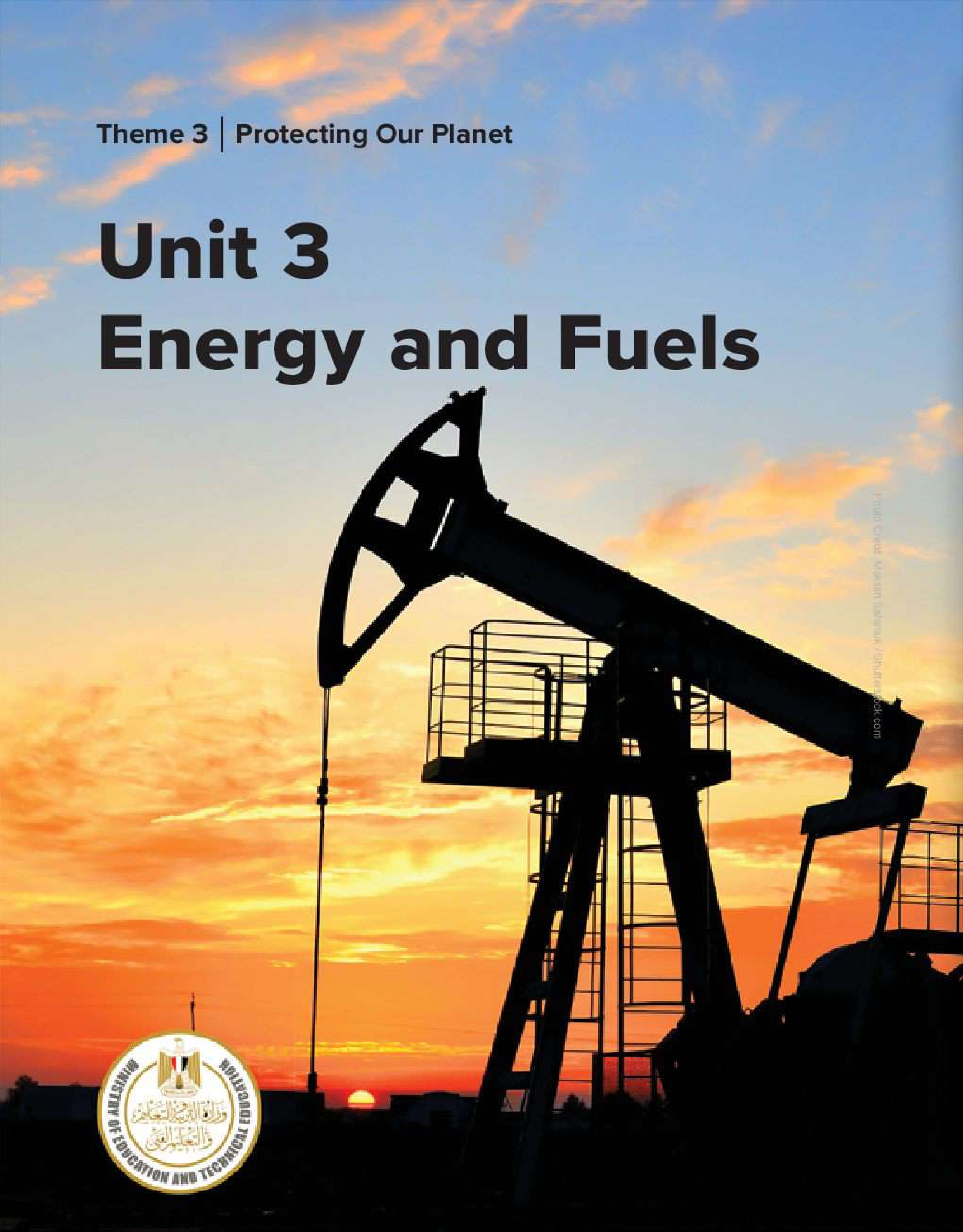


Photo Credit: Maksim Safaniuk / Shutterstock.com

What I Already Know

This unit is all about energy and fuels. **Think** about how humans use fuel for energy. **Look** at the first two images on this page. What types of fuels are shown? How is the energy from the fuel being used? Then, **look** at the third image. You can see the fire, but are there other examples of energy from fuel that you can see in the photo? **Write** some ideas you have about how humans use fuel and how we use energy that comes from fuel.

Quick Code:
egs4250

Talk Together Think about the items in your house that require energy or fuel. Where do you think that energy or fuel comes from? Share your ideas with a partner.

Now that you have learned about energy as it relates to work and motion, this unit will help you look at energy in a different way. During this unit, you will learn a lot more about how energy helps humans do everything from cook food to drive cars to power everyday devices. You will explore where this kind of energy comes from. You will explore different types of fuels and learn the difference between renewable and nonrenewable resources. You will investigate certain kinds of renewable energy that come from the sun, wind, or water. Finally, you will consider the impact on the environment when we use different kinds of resources for energy, whether they are renewable or nonrenewable.

Water for Energy

The sight of tremendous amounts of water flowing down a river and over a waterfall is impressive. All that water has a lot of kinetic energy. By the end of this unit, you will be able to describe how that energy can be turned into useful electricity. You will also be able to evaluate how obtaining that energy impacts the environment.

Video

Water for Energy

Watermill

Did you ever think that we could use water as an energy resource? Have you ever felt the force of waves on the sea or ocean? Maybe you have observed a waterfall and heard the sound the rushing water makes. For years, people have used water to create energy by using the force of falling or moving water to move objects like a watermill. Water moves through the slats on the wheel and turns it, creating energy to move machinery and equipment. In modern times, scientists and engineers have developed a more sophisticated solution to harness the power of water. Dams are built to harness the flow of a river through a system that captures the power of the moving water. Hydroelectric power is the term we use to describe using the power of moving water to turn a large turbine to generate electricity. Dams can create lots of clean energy, but they also have an impact on the surrounding ecosystems by changing the path of water.

Solve Problems Like a Scientist

Unit Project: Dam Impacts

Quick Code: egs4251

In this project, you will use what you know about energy and the environment to assess the positive and negative impacts of building a dam on the surrounding environment and community.

Questions

- What do you notice about this image of the Kariba Dam in Southern Africa?
- How do you think dams can change the landscape?
- How do you think changing the landscape can affect plants, animals, and humans?


Kariba Dam

Ask Questions About the Problem

You will research solutions to one of the negative impacts of building a dam. **Write** some questions you can ask to learn more about the problem. As you learn about how energy use affects the environment, **write** answers to your questions.

CONCEPT 3.1

Devices and Energy

Student Objectives

By the end of this concept:

- [ ] I can develop models based on observations that describe how everyday devices transform energy.
- [ ] I can use observations and evidence to explain how energy is transferred from place to place.

Key Vocabulary

- [ ] chemical energy
- [ ] Earth
- [ ] energy conservation
- [ ] energy source
- [ ] energy transfer
- [ ] sound
- [ ] sun

Quick Code:
egs4253

Activity 1

Can You Explain?

In the last unit you learned about how objects in the world move around you by exploring the relationships between energy, work, and force. Now you will connect your learning about energy to explore how it can be transformed through devices.

What kinds of energy transfer must occur for light from the sun to power a cell phone?

Quick Code: egs4254

Life Skills **I can share ideas I am not yet sure about.**

Activity 2

Ask Questions Like a Scientist

Quick Code: egs4255

Energy in Remote-Controlled Cars

Every day you may use devices that need energy to work. Have you ever thought about where that energy comes from? **Read** the text and **look** at the image. Then, **complete** the activity that follows.

Energy in Remote-Controlled Cars

Many toys can be operated remotely. Remote-controlled cars, trucks, planes, boats, and robots are fun to use. All these devices need energy to make them move and do tasks such as turning corners, moving remote arms, or operating cameras.

Where do they get this energy from? All of these devices use electricity. Batteries are their onboard **energy source**. When the batteries are exhausted, they must be recharged or replaced with new ones. That is easy. Simply plug the device into the nearest charger or purchase new batteries at a store. But sometimes that is not possible. What other energy sources do you think devices use?

Life Skills I can identify problems.

Think about the devices you use in your daily lives and the energy they use.
Write three questions you have in the chart below.

I wonder . . .
I wonder . . .
I wonder . . .

Activity 3

Analyze Like a Scientist

Quick Code: egs4256

Mars Rover

Let's explore something outside our world. Have you ever seen a picture of a rover on the planet Mars? As the rover explores Mars, it needs energy to do its work. **Think** about how it gets its energy. To help you think about this, **look** at the picture and **read** the text. Then, **complete** the activity that follows.

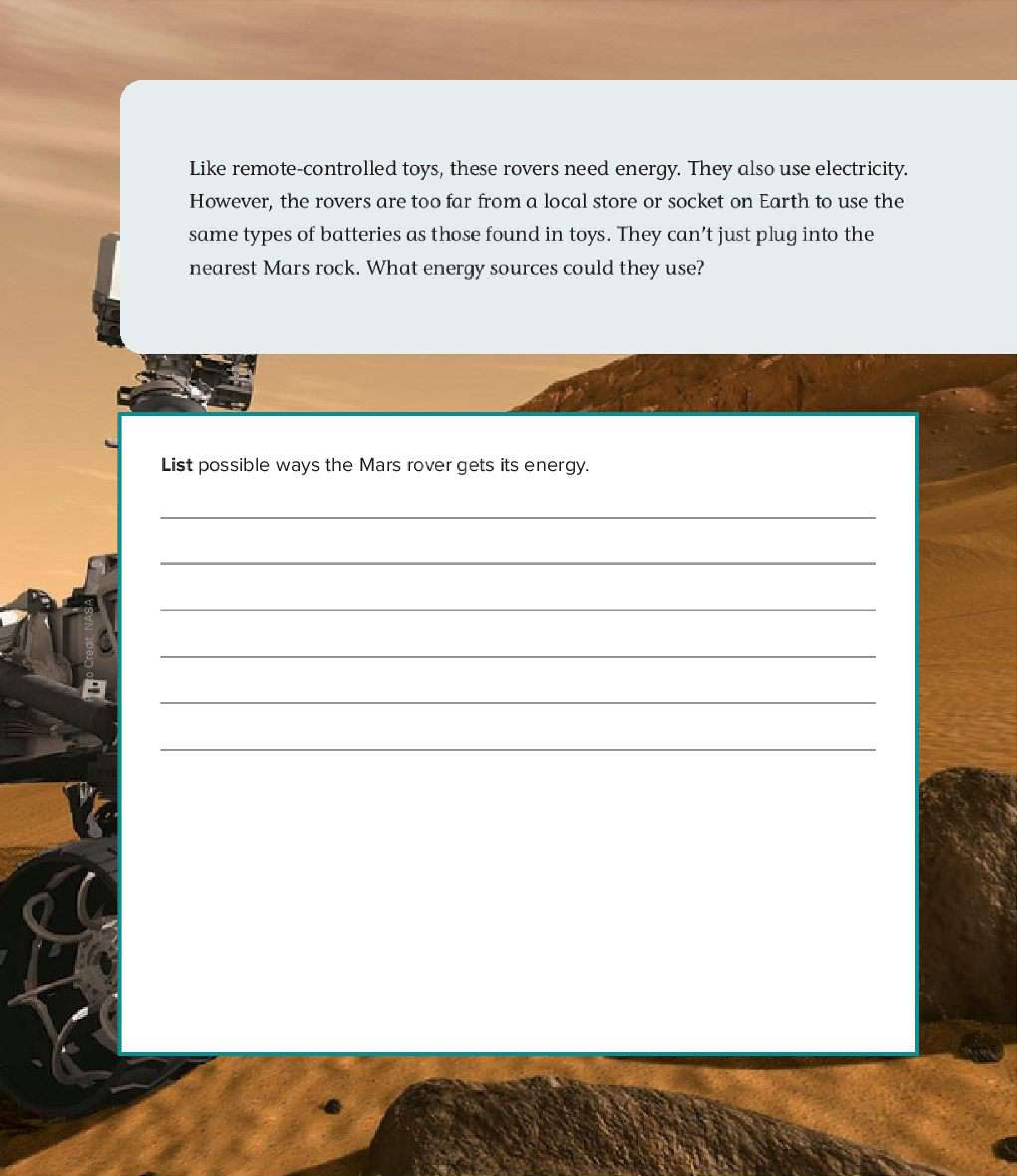
Mars Rover

Mars never gets closer to **Earth** than about 54 million kilometers. That's a long way. It takes a spacecraft about six months, usually longer, to get there.

Mars Rover Curiosity

Over the past few decades, humans have sent many missions to Mars. None of these missions included people; they all used different types of remotely operated vehicles or robots. These robots have performed a variety of jobs. One of the most famous robots is the Mars rover Curiosity, which travels on the surface of the planet.

Life Skills I can analyze a situation.



Like remote-controlled toys, these rovers need energy. They also use electricity. However, the rovers are too far from a local store or socket on Earth to use the same types of batteries as those found in toys. They can't just plug into the nearest Mars rock. What energy sources could they use?

List possible ways the Mars rover gets its energy.

Activity 4

Evaluate Like a Scientist

Quick Code: egs4259

What Do You Already Know About Devices and Energy?

You have been thinking about how different devices get the energy they need to function. Now let's think about these devices when they are in use. How does the energy change? **Look** at the pictures. Then, **discuss** the questions with a partner.

Talk Together What is the source of energy, or energy input, for each device? What is the energy output?

Life Skills I can analyze a situation.

Photo Credit: Inc / Shutterstock.com

Where Does the Energy We Use Come From and Go To?

Activity 5

Analyze Like a Scientist

Quick Code: egs4266

Energy Chains

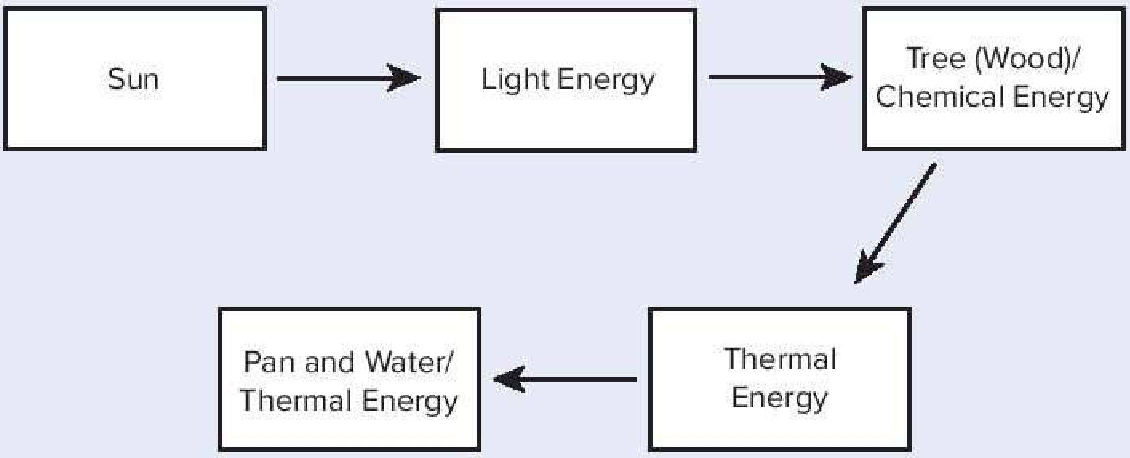
Consider what you have learned about energy sources so far. How would you trace energy from its source to a device in use? **Read** the text and **look** at the diagrams of energy chains. **Share** your understanding with your partner.

Energy Chains

Most energy we use is made inside the **sun**. But how does that energy get inside the devices we use? We can draw energy chains that show the path of energy from the sun to different devices. A simple energy chain familiar to all of us is eating. This energy chain starts with energy from the sun hitting Earth as light. A plant, such as an orange tree, transforms that light energy into stored **chemical energy** as it makes sugars. When you eat the orange, your body uses the chemical energy to move.

Energy Chains, *continued*

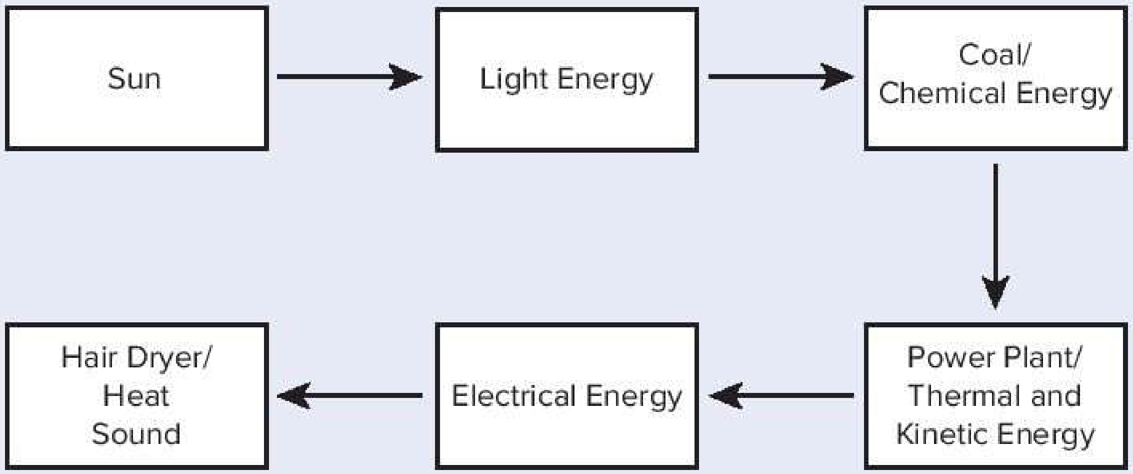
How can an energy chain help us understand the energy of devices? Let's start with a simple example: heating a pan of water over a fire. The light energy of the sun helps a tree grow. The energy is stored in the tree as chemical energy. When the wood is burned, it releases thermal energy that heats the water.



The energy chain for a hair dryer is more difficult. The electrical energy that powers a hair dryer reaches it through an electric cord that is made of copper. The electrical energy comes from a power plant of some type. Perhaps it burned coal or gas to make this electrical energy. But where did this energy originally come from?

Photo Credit: Inc/Shutterstock.com

We already have many of the links. We have traced the energy backward to the power plant. If that power plant burned coal, a form of chemical energy, then we need the link to the sun. Coal was formed millions of years ago from dead trees. Where did the trees get their energy from? You guessed it: sunlight. So now we can diagram the energy chain for a hair dryer.



Not all energy that enters an energy chain reaches the device and gets used as we intend. At each link in the chain, some energy escapes as other forms. It still exists, but it gets transformed into another energy form that is not used by the device. Most of this energy escapes in the form of heat.

Activity 6

Think Like a Scientist

Quick Code: egs4260

Energy and Everyday Devices

In this investigation, you will use what you know about types of energy to describe the energy input and output of various devices. Before you begin your observations, review with your group some of the examples of energy input and output from previous activities. As you work, **discuss** your ideas and **record** your observations. When you finish, **reflect** on your experiences and **answer** the questions. As you investigate, record your observations in the table provided.

Energy of Everyday Devices

Device	Function	Form(s) of Energy In	Form(s) of Energy Out
Table lamp	Providing light	Electrical	Light, thermal

Life Skills **I can use information to solve a problem.**

What Will You Do?

1. Analyze each device.
2. Determine the energy input for the device.
3. Determine the energy output for the device.
4. Record your observations in the Energy of Everyday Devices table.

Think About the Activity

How did you determine the forms of energy that went into the use of each device?

How did you determine the forms of energy that came out of each device as it was used?

Does all of the energy that goes into each device come out as part of its function, or is some of the energy wasted? Support your answer with examples.

Activity 7

Observe Like a Scientist

Quick Code: egs4261

The Conservation of Energy

Think about what you already know about changes in energy. Do you think energy can disappear or be used up? **Read** the text and **watch** the video to learn about **energy conservation**. Then, **answer** the questions that follow.

You already know that energy can change and that there are many types of energy. Energy is constantly converted from one form or type to another. Consider this example: If you have ever ridden a bike, you are part of a series of events that involve energy conversion.

You eat breakfast so that the chemical energy in your food will give your body energy. As you push on the bike pedals with your legs, you cause the bike to move. You are changing chemical energy into mechanical energy. The mechanical energy in the bike is also becoming heat energy as the tires rub on the road.

Life Skills I can identify problems.

Here is another example of a different type of energy conversion. When you turn on a light bulb, you are starting an energy transformation. Electrical energy that powers the light bulb is converted into light and heat energy. The room becomes brighter with the light from the bulb. If you hold your hand near some light bulbs, you can feel their heat.

While energy can change forms, it never goes away. Energy cannot be created nor destroyed. This is the Law of Conservation of Energy. It means that new energy cannot simply be made from nothing, and old energy does not disappear. Energy just changes types and forms.

What is the definition of the phrase *conservation of energy*?

What are the different forms of energy involved when a light bulb is turned on?

Activity 8

Analyze Like a Scientist

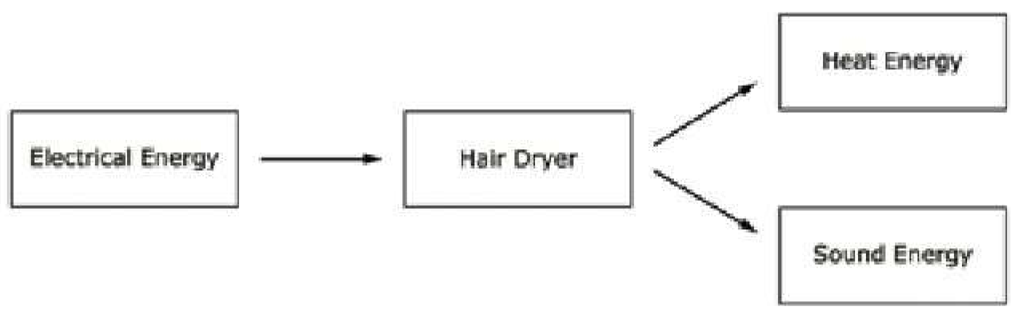
Quick Code: egs4262

Follow the Flow

No one likes it when their cell phone battery dies. Why does this happen? Where does the energy go? **Read** the text and **look** at the diagram to find out how the energy that powers a device is converted into other types of energy and where it flows. Then, **answer** the question that follows.

Follow the Flow

Energy is conserved. It is neither created nor destroyed. What does this mean for how energy powers our devices? All the energy that goes into a device must eventually leave it, either in the same or a different form. Devices have energy that goes in and energy that goes out. We call these energy *inputs* and *outputs*.



When we trace the flow of energy, all energy must have a place to go. It might seem like a device "loses" energy. In fact, the energy has been converted into another type of energy. Sometimes this converted energy does not help do what the device is designed to do.

Think of a hair dryer. The energy input to the hair dryer comes through the cord as electrical energy. Inside the dryer, that energy is changed into other types. Thermal energy, **sound**, and kinetic energy (from the fan and moving air) leave the dryer. These are its energy outputs. The noise of the hair dryer can seem like "lost" energy because the sound energy is not contributing to the job of the device: to dry hair.

Sometimes, energy enters a device and is stored inside it for a while. A cell phone is one example. Energy enters the device as electrical energy. It is stored in the battery of the phone as chemical energy. When a phone is on or in use, the phone changes some of this stored energy. The chemical energy in the battery is converted into other types. Can you think of how the phone uses this stored energy in its battery?

List the different ways a cell phone uses its stored energy.

Activity 9

Think Like a Scientist

Quick Code:
egs4267

Build an Energy Chain

You have now seen a few energy chain examples. In this investigation, you will build your own energy chain. Your model should show **energy transfer** pathways from input to output. Do not forget to consider all the possible energy transfers, not just those that help the device do its job.

What Will You Do?

Use magazine pictures or illustrations to **construct** an energy chain for a common device. **Label** each picture with the form of energy and whether the energy is being transferred (as the same type) or transformed (into a different type).

Life Skills I can try new things.

Think About the Activity

How can these types of models be used to track energy pathways?

What are the limitations of these types of models?

Activity 10

Record Evidence Like a Scientist

Quick Code: egs4270

Energy in Remote-Controlled Cars

Now that you have learned about energy transformations, look again at the image of a remote-controlled car. You first saw this in Wonder.

How can you describe the energy in a remote-controlled car now?

How is your explanation different from before?

Life Skills I can review my progress toward a goal.

Look at the Can You Explain? question. You first read this question at the beginning of the lesson.

Can You Explain?

What kinds of energy transfer must occur for light from the sun to power a cell phone?

Now, use your new ideas to write a scientific explanation to answer this question. First, **write** your claim. Your claim is a one sentence answer to the Can You Explain? question. It should not start with a yes or no.

My claim:

What kinds of energy transfer must occur for light from the sun to power a cell phone?

Next, **record** the evidence that supports your claim. Then, **explain** your reasoning.

Evidence	Reasoning That Supports Claim

Now, **write** your scientific explanation.

The energy transformations that must occur for light from the sun to power a cell phone are . . .

Optional Digital Activity 11

Analyze Like a Scientist

Careers and Energy in Systems

Go online to complete this activity.

Quick Code: egs4271

Optional Digital Activity 12

Evaluate Like a Scientist

Review: Devices and Energy

Go online to complete this activity.

Quick Code: egs4272

CONCEPT

3.2 About Fuels

Student Objectives

By the end of this concept:

- [ ] I can describe patterns in how different types of fossil fuels are formed and predict the properties and uses of different types of fossil fuels.
- [ ] I can describe how the use of energy and fuels affects the environment.

Key Vocabulary

- [ ] energy efficiency
- [ ] fossil fuels
- [ ] fuels
- [ ] generate
- [ ] nonrenewable
- [ ] pollution
- [ ] renewable
- [ ] renewable resource

Quick Code:
egs4274

Activity 1

Can You Explain?

We previously learned about energy chains and how energy can be traced back to the sun. Now let's think about fuels such as gasoline, oil, and coal.

Where does the fuel we use every day come from?

Quick Code:
egs4275

Life Skills **I can share ideas I am not yet sure about.**

Photo Credit: (a) ANATOLY FOV / Shutterstock.com, (b) ThePowerPlant / Shutterstock.com

Activity 2

Ask Questions Like a Scientist

Quick Code:
egs4276

Fuels and Road Trips

Have you ever been on a road trip? Cars and trucks need energy to move. Where do you think this energy comes from? **Read** about a road trip one family took and think about times you have ridden in a car. Then, **write** questions you have about **fuels**.

Fuels and Road Trips

They were an hour into the long road trip to Aunt Nora's house. Unlike her younger brother, Hani, who was fast asleep, Samar was getting bored. She looked over her mom's shoulder to see how fast they were going. It was then that Samar noticed how low the gas was. "Hey Mom, we are running out of gas, and there are no gas stations on this highway."

Her mom glanced down at the gauge. "Wow. I'll check out the next exit. Perhaps there is a gas station."

Life Skills I can decide if a source is reliable.

At last, seven kilometers farther along the highway, a turnoff came into view. The car raced up the ramp and sputtered its way over to the nearest gas station. The sputtering woke Hani up. He looked worried. "Are we there yet? What's wrong with the car?"

Pumping Gas

"The car is out of gas."

The sputtering stopped, and the car slowly rolled into the gas station. "Are we going to make it?" Hani gasped.

The car rolled to a stop close to the nearest gas pump. "We just made it," his mother said. "Another minute and we would have been pushing the car along the side of the road."

While the attendant filled the tank, Hani wondered out loud to his mother, "Hey Mom, why do we need gas? Why don't they make cars that don't need gas? Then we wouldn't need to stop. We'd be at Aunt Nora's already."

His mother smiled at Hani's pattern of asking a string of questions all at once. She thought for a moment, then answered, "Cars need energy to run. The car burns the gas in its engine, and the engine turns the wheels. No gas, no movement."

Fuels and Road Trips, *continued*

“But why?” said Hani. “Can’t we run the car on something else? Could we get a car that runs on sunshine?”

His mother laughed. “Well, I don’t think they sell them yet. And anyway, how would we drive at night?”

What are fuels, and what are they used for? Was Hani’s mother right in the way she described what gas does inside a car? Do you think Hani’s idea about a car that runs on sunshine is a good one? In this concept, you will learn about fuels and some other sources of energy that we use.

After reading the story, what questions would you like to investigate about different types of fuels, where they come from, and how we use them?

Activity 3

Evaluate Like a Scientist

Quick Code: egs4277

What Do You Already Know About Fuels?

Fuels We Use

We use fuels in many different ways every day. Does your family need fuel to cook or heat your home? Let's think about different fuels, where they come from, and how they can be used as energy. **Choose** one of the fuels pictured here and be ready to share your ideas.

Gasoline

Natural Gas

Coal

Wood

What Are the Different Types of Fuels?

Activity 4

Analyze Like a Scientist

Quick Code:
egs4278

Types of Fuel

Have you ever wondered about the different types of fuels we use? **Watch** the video and **read** the text with a partner to learn about different types of fuels and where they come from. Then, **classify** the information on the graphic organizer and respond to the questions.

Types of Fuel

Fuels are substances that, when burned, release thermal energy. Wood is the most ancient fuel and is still widely used throughout the world. A wide variety of plant and other materials are used for fuels. Because they are made from living things, they are called biofuels. For example, charcoal, made from wood, is an important fuel.


Cooking Using Charcoal

Life Skills **I can identify problems.**

Some plants can be turned into liquid fuels. For example, switch grass, wood chips, and corn all can be used to make a liquid fuel.

If we trace back to where the energy in these fuels comes from, we find that they started with light energy from the sun. These fuels are used around the world everyday, but the supply is also continually renewed as plants grow. For this reason, they are called **renewable** fuels.

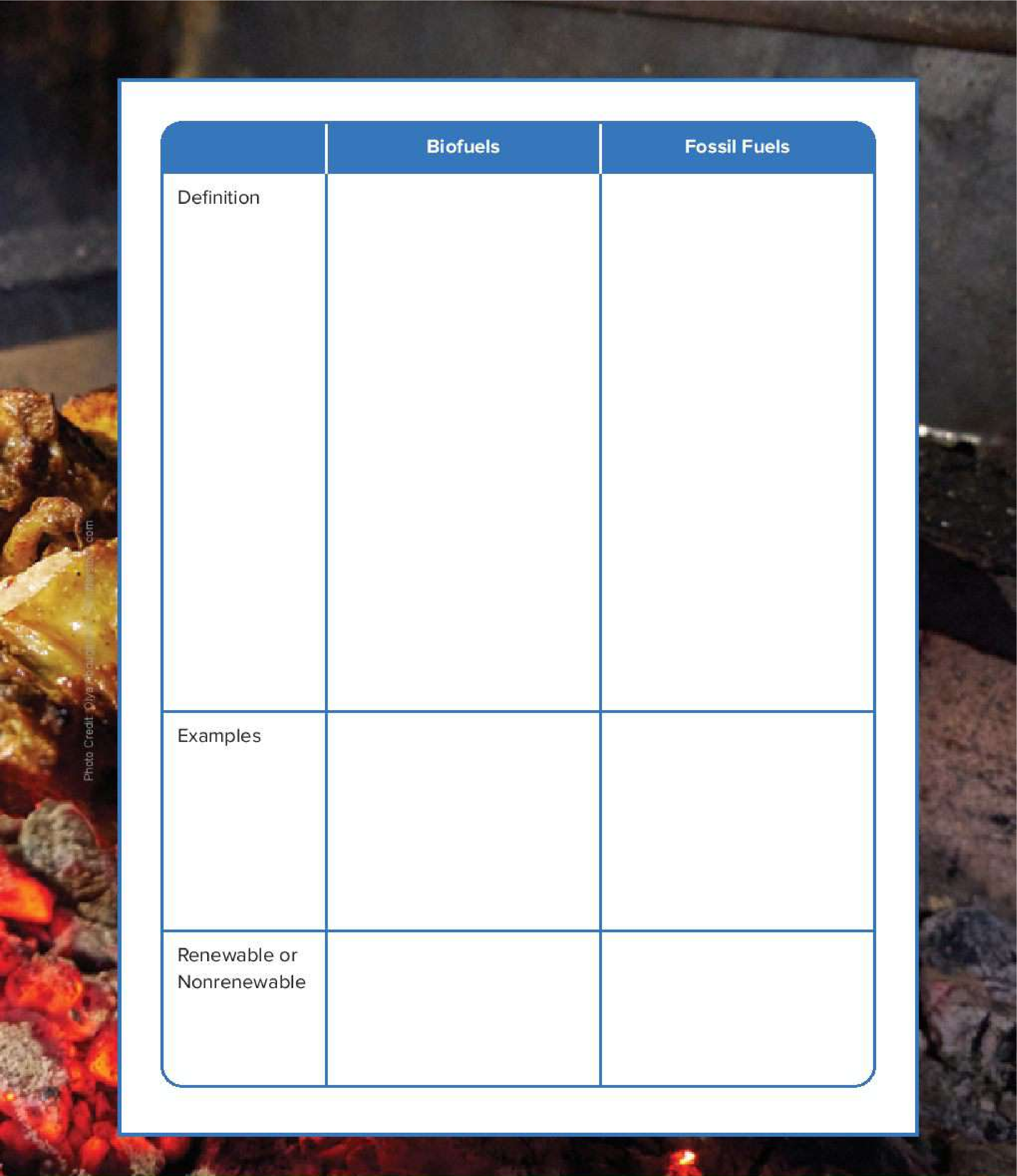
Renewable fuels require careful management. For example, using wood as fuel requires cutting down trees. While some trees may grow to their full height in one person's lifetime, many trees only grow a few centimeters each year. This means that it would take many lifetimes for these trees to reach maturity. Cutting down trees at a faster rate than they can grow leads to deforestation, which has a variety of negative impacts on our environment. Using wood at a rate that is sustainable means being careful not to use a resource faster than it can be replaced.

Fossil fuels are fuels that were formed from the remains of plants and animals that lived millions of years ago. Over a very long time, these remains built up and became buried under Earth's surface. For example, around 300 million years ago, large sections of Earth's continents were covered in swamps. When the trees and plants in these swamps died, they got covered in mud and sand.

Eventually the decayed or broken-down plants were covered in hundreds of meters of mud and rock. Earth's heat and pressure turned these remains into coal. Fuels such as coal are formed mainly from ancient plants, while fuels such as oil and gas form mostly from tiny, ancient sea animals. Gasoline is a fuel made from oil. Coal, gasoline, and natural gas are all examples of fossil fuels.


Coal Train

Fossil fuels such as coal, oil, and gas form very slowly over millions of years. This means that we use them up much faster than they are formed. For practical purposes, once we use fossil fuels, they are gone. They cannot be easily renewed. For this reason, fossil fuels are said to be **nonrenewable**.



	Biofuels	Fossil Fuels
Definition		
Examples		
Renewable or Nonrenewable		

What is the difference between a renewable fuel and a nonrenewable fuel?

If you have to wait for a tree to grow in order to use it for fuel, is it a better choice than using fossil fuels? Why or why not?

Where did the energy in these fuels originally come from?

Optional Digital Activity 5

Observe Like a Scientist

Fossil Fuels

Go online to complete this activity.

Quick Code:
egs4281

Activity 6

Analyze Like a Scientist

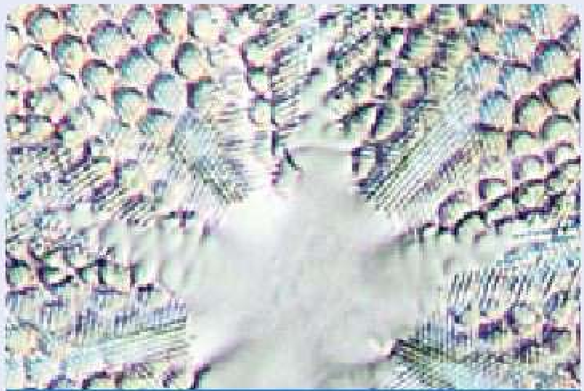
Oil and Water

Quick Code:
egs4282

Oil and water are two types of resources that humans can use to generate power. However, these two energy resources have many differences. **Read** the text. Then, **answer** the questions that follow.

Oil and Water

Oil comes from deep in the ground. Scientists think that oil formed from the decomposition of sea creatures. As the sea creatures died, their remains settled on the ocean floor. They became covered with layers of sediment and rock.



Sea Creature under a Microscope

Over many millions of years, the sediment and rock built up more and more layers. All of these layers pressed down. The layers created great pressure and heat. This pressure and heat slowly turned the remains into oil.

Oil Rig

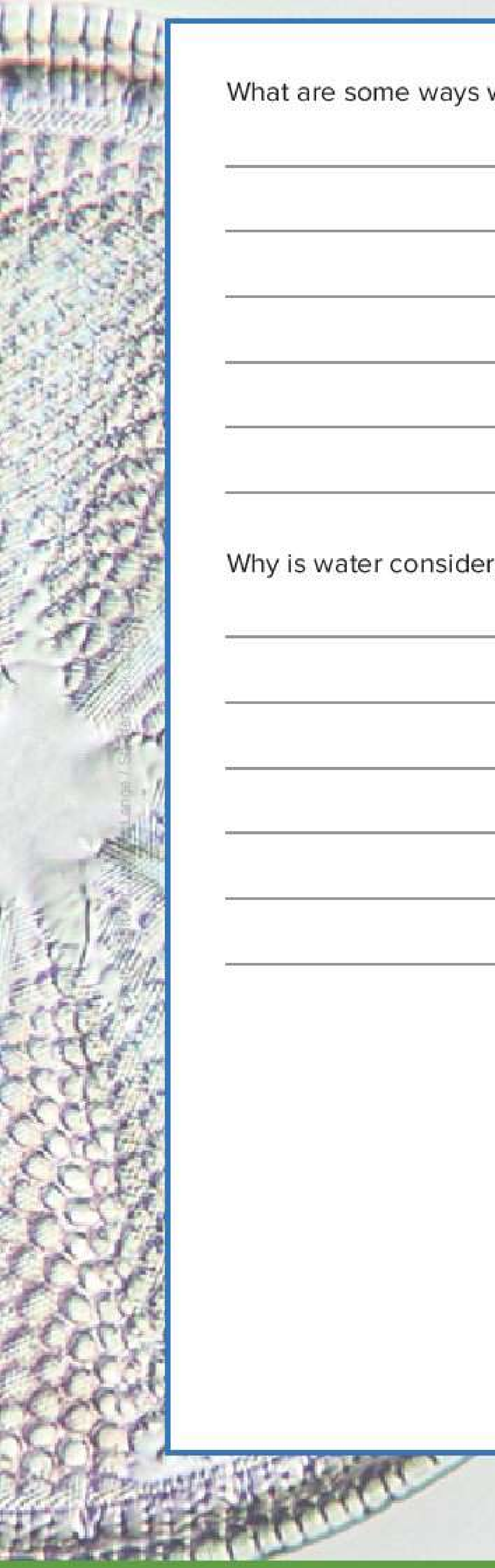
Oil is a nonrenewable resource.

A nonrenewable resource is a natural material that is used faster than it can be replaced. We use oil faster than new oil can form. Therefore, we must use oil very wisely because we could run out of it.

Unlike oil, water is a **renewable resource**. A renewable resource is a natural material that can be replaced soon after it is used. Even though water is renewable, we still must be careful when we use it. We should not waste or pollute water. If we do, then water may not be replaced as quickly as we need it.

Moving Water

Oil and water are very different. However, we must use them both very wisely.



What are some ways we could conserve these resources?

Why is water considered a renewable resource?

Activity 7

Evaluate Like a Scientist

Quick Code:
egs4283

Fossil Fuel Formation

Let's see if you understand how fossil fuels form. The following are the steps involved in the formation of fossil fuels. **Write** them in the correct order.

Remains changed to become coal, oil, and natural gas.

Remains were buried.

Living things that lived a long time ago died.

Heat and pressure affected the remains.

Photo Credit: ANATOLY FOTO / Shutterstock.com

Life Skills **I can decide on a solution to use.**

Activity 8

Think Like a Scientist

Quick Code: egs4284

Living without Electricity

In many regions, nearly all electricity is generated by gas and oil, which are nonrenewable energy sources. Using renewable resources, such as hydropower and wind, is beginning to increase, but these energy sources are still very new. No matter which energy source is used, it is important for everyone to understand how much electricity they use and find ways to practice **energy efficiency**. In this activity, you will document your experience of spending some time without using electricity.

What Will You Do?

Choose a minimum of two hours to NOT use electricity. **Write** about your experience.

Think About the Activity

How long were you able to go without using electricity?

What types of devices would you normally have used during this period of time? What did you do instead?

How did you feel during and after this experience? Do you feel that you normally take electricity for granted?

What can you do at home to conserve fuels and avoid wasting electricity?

Activity 9

Analyze Like a Scientist

Quick Code:
egs4285

Using Fossil Fuels to Generate Electricity

You already know that gasoline is used to provide energy to make cars move. But what about the electricity you use to power the lights in your home? Where does it come from? How are fuels involved in generating electricity? **Read** the text. Then, **complete** the activity on the following page.

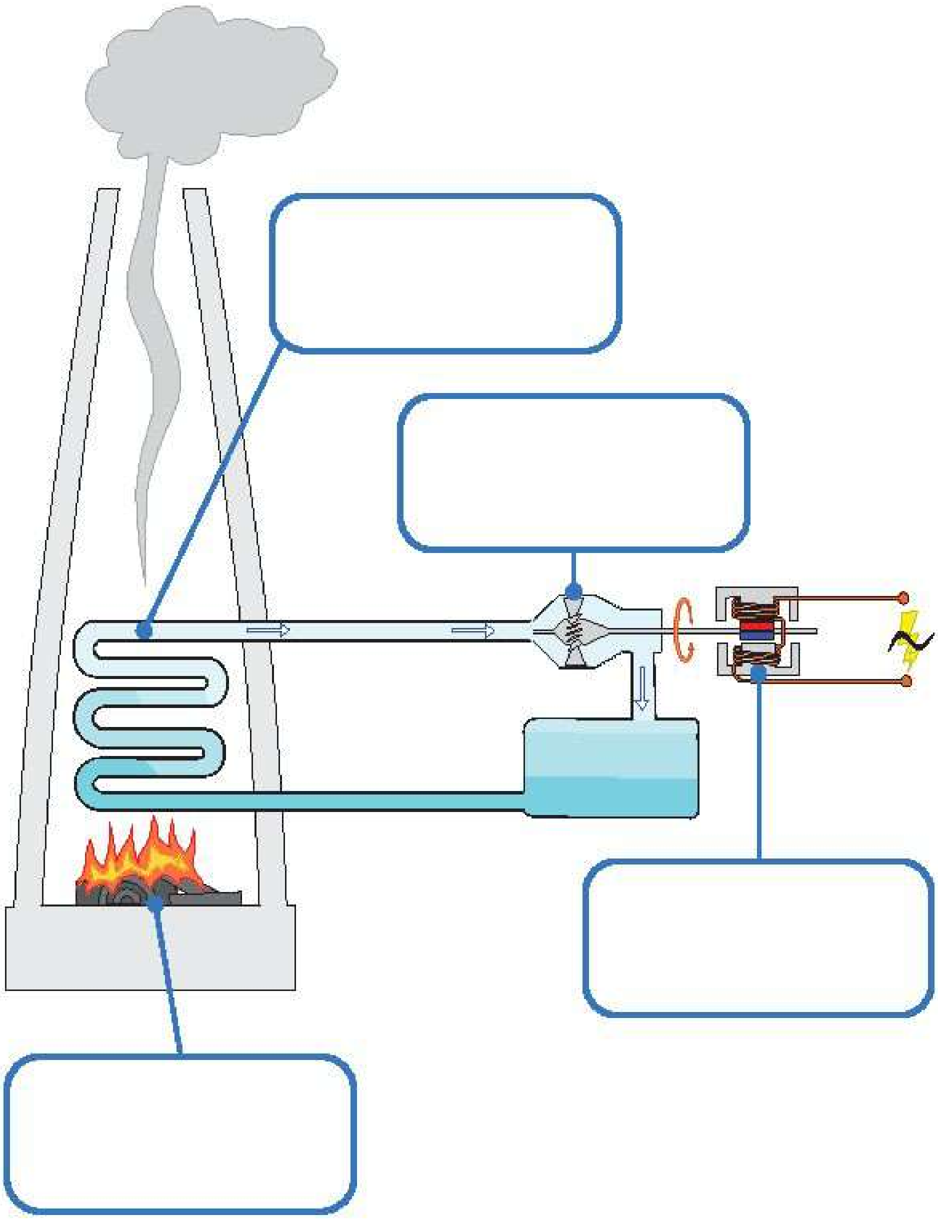
Using Fossil Fuels to Generate Electricity

Coal Power Plant

Electricity is typically generated in a power plant. At the beginning of the process, a fuel is burned to release thermal energy. Common fuels include oil, coal, and natural gas. This thermal energy is used to heat water to make steam. The steam is directed through pipes and used to turn a device called a turbine. The kinetic energy of the turbine is used to spin a generator. A generator transforms kinetic energy into electrical energy. The electrical energy travels down wires to homes and businesses.

It is likely that if you flip a light switch, the electricity you are using to make the bulb light up was generated from burning oil, coal, or natural gas to create steam.

Look at the simple model of how a power plant works. First, **finish** the model by adding a sketch of how the electricity travels to your home or school. Then, use the text to **identify** each step in the flow of energy from a fuel to the lights in your home. **Label** each step in the process.



Activity 10

Observe Like a Scientist

Quick Code: egs4330

Big City Environmental Concerns

Using fossil fuels can have negative impacts on the environment. **Read** the text, **watch** the video, and **look** for reasons why big cities have air pollution problems.


Video

Population demands and increased industry and agriculture have resulted in pollution problems around the world. Burning fuels for energy can pollute the air. Pesticides used in farms can be carried into streams when it rains. The chemicals used at many factories can pollute the air as well as nearby water and soil.

Pollution, in the form of smog, is especially severe in large cities. Environmental concerns are being addressed in large cities worldwide, where smog from automobile emissions causes widespread irritation to eyes and lungs. Medical researchers have found that smog is full of small particles that we breathe in. Because these pollutants are so small, they can irritate our lungs and damage the tissue of the respiratory system. Efforts to make laws to prevent high smog levels in large cities are making slow progress.

Talk Together Now, talk together about the sources of air pollution in big cities. What is the potential impact of air pollution on the respiratory system?

Activity 11

Analyze Like a Scientist

Quick Code: egs4331

Burning Fossil Fuels and Pollution

What happens when fossil fuels are burned to release energy? **Read** the text. As you read, **complete** the graphic organizer at the end of the passage to show how burning fossil fuels affects the environment.

Burning Fossil Fuels and Pollution

In the 1800s, people began to need more energy than ever before. They needed energy to run factories, cars, trains, and ships.

Power Plant Emissions

Since then, the demand for energy has continued to rise. More energy is needed to supply electricity to homes, schools, businesses, and factories. The problem has always been finding a way to get all this energy.

The solution was fossil fuels. Fossil fuels include coal, oil, and natural gas. Burning fossil fuels releases energy. People can use this energy to make things work. For example, people can burn coal or oil in a power plant. They can use the energy from the fuel to produce electricity. Then, they send the electricity through power lines to homes, schools, and factories.

However, burning fossil fuels generates more than just energy. It also makes pollution. For example, burning coal and oil produces a gas called carbon dioxide. Carbon dioxide can combine with water in the air to make carbonic acid, which can cause acid rain. Acid rain can kill trees. It can change the chemistry of lakes and kill fish. It can change the chemistry of soil. Acid rain can dissolve some rocks, including some used for building.

Carbon dioxide from burning fossil fuels can also cause another problem. Carbon dioxide gas can collect in the air. It forms a layer in the atmosphere that traps heat on Earth. As a result, Earth's temperatures slowly rise. Rising temperatures on Earth is called global warming.

At the moment, the only solution to stop acid rain and global warming is to conserve energy. The less energy we use, the fewer fossil fuels we burn. The fewer fossil fuels we burn, the less carbon dioxide and other pollutants we put in the air we need to breathe.

Conserving energy not only reduces pollution, but it also conserves the supply of nonrenewable fossil fuels. Conserving fossil fuels makes them last longer and keeps Earth cleaner.

Topic: ____________________

Cause | **Effect**

Why Is It Important to Use Fossil Fuels Wisely?

Activity 12

Analyze Like a Scientist

Quick Code: egs4287

Conserving Fossil Fuels

You have learned about how fossil fuels are burned to generate the electricity that powers our homes. Recently, you spent a few hours trying to live without electricity. Consider how you felt about your experience while you **read** about conserving fossil fuels. As you read, **underline** the main idea of the passage and **highlight** ways to conserve fossil fuels.

Conserving Fossil Fuels

The supply of fossil fuels on Earth is limited. Since they take millions of years to form, fossil fuels cannot be replaced as quickly as we use them. Eventually, fossil fuels will run out. Using fewer fossil fuels to meet our needs is the best way to conserve these resources. There are many ways to conserve fossil fuels. Some ideas are walking or biking instead of driving or turning off the lights when you are not in a room.

Public Transportation

Conserving Fossil Fuels, *continued*

Another problem with the use of fossil fuels is how they affect our planet. Burning fossil fuels to generate electricity and power vehicles releases gases into the air. These gases can cause pollution and also trap warm air in our atmosphere. You may have heard of global warming or climate change. The burning of fossils fuels is one of the most important causes of this problem.

Replacing fossil fuels with renewable sources of energy can greatly conserve fossil fuels. Solar, water, and wind are renewable sources of energy. Using renewable energy means that we will not run out of our energy sources nor overheat our planet. The main drawback has been that it currently costs more money to produce energy from renewable resources than from fossil fuels.

Talk Together What are the drawbacks to using fossil fuels to generate power? How do you think that people can benefit from conserving energy?

Optional Digital Activity 13

Observe Like a Scientist

Value of Renewable Resources

Go online to complete this activity.

Quick Code: egs4288

Activity 14

Evaluate Like a Scientist

Quick Code:
egs4290

Using Fuels

You have already learned a lot about the different types of fuels that we use. You know that fuels can either be classified as renewable or nonrenewable. In the word bank, you will find a list of some familiar fuels. **Write** the fuels in the correct category.

Once you have finished, your teacher will provide you with a list of other fuels. Although some of the fuels may seem unfamiliar, try to sort them using what you already know.

coal	gasoline	natural gas	oil
solar energy	wind power	wood	

Renewable	Nonrenewable

Activity 15

Record Evidence Like a Scientist

Quick Code:
egs4291

Fuels and Road Trips

Now that you have learned about how we use different types of fuel, **look** again at the image Fuels and Road Trips. If you need to, go back and **read** the text in Wonder. Then, **write** your answers to the questions that follow, using what you have learned in this concept.

How can you describe fuels and road trips now?

____

____

How is your explanation different from before?

____

____

Once scientists have asked questions and gathered information from multiple sources, they share what they have learned. **Look** at the Can You Explain? question. You first read this at the beginning of Wonder. **Think** about how you would answer this question now.

Can You Explain?

Where does the fuel we use every day come from?

Photo Credit: (a) ANATOLY FOTO / Shutterstock.com, (b) Andrey Pavlov / Shutterstock.com

Now, use your new ideas about where fuel comes from to write a scientific explanation to answer this question. First, **write** your claim. Your claim is a one sentence answer to the Can You Explain? question. It should not start with a yes or no.

My claim:

Next, **record** the evidence that supports your claim. Then, **explain** your reasoning.

Evidence	Reasoning That Supports Claim

Now, write your scientific explanation.

Fossil fuels are formed by . . .

Optional Digital Activity 16

Analyze Like a Scientist

Oil Drillers and Underwater Robots

Go online to complete this activity.

Quick Code:
egs4292

Activity 17

Evaluate Like a Scientist

Quick Code:
egs4293

Review: About Fuels

Think about what you have learned so far about fuels. In the space provided, first **discuss** the characteristics, advantages, and disadvantages of different types of fuels. Then, **explain** renewable and nonrenewable energy sources.

Talk Together Think about what you saw in Get Started. Use your new ideas to discuss fuels, how they are formed and used, and how we can use them wisely.

Life Skills **I can review my progress toward a goal.**

CONCEPT

3.3 Renewable Energy Resources

Student Objectives

By the end of this concept:

- [ ] I can apply scientific ideas to design, test, and refine devices that convert energy from one form to another.
- [ ] I can explain the use of renewable resources in the generation of electricity.
- [ ] I can develop models based on observations and evidence that energy is transferred from place to place.

Key Vocabulary

- [ ] heat
- [ ] light
- [ ] radiation
- [ ] solar energy
- [ ] turbine
- [ ] watermills
- [ ] windmills

Quick Code:
egs4295

Activity 1

Can You Explain?

Solar panels are used to power the street lights on this city road.

What are the different ways we can use renewable energy to generate electricity?

Quick Code: egs4296

Life Skills **I can share ideas I am not yet sure about.**

Activity 2

Ask Questions Like a Scientist

Quick Code: egs4297

Windmills and Watermills

People have always used machines to make tasks easier, but we have not always had electricity to power these machines. How do you think machines worked when there was no electricity? **Read** the text and **look** at the pictures. Then, **complete** the activity that follows.

Windmills and Watermills

Imagine you were born 400 years ago. Life was hard. People needed machines to make their lives easier. What would people need machines to do? One of the most common jobs of **windmills** and **watermills** was to crush grain to make flour. This took place at the mill.

Let's Investigate Windmills and Watermills

Life Skills **I can ask questions in new situations.**

Some mills used water, and other mills used wind. Can you think of some of the advantages these early mills had? What about disadvantages? Current wind and water turbines look both similar to and different from the windmills and watermills built hundreds of years ago. Why do you think they look different?


Windmill, mid-1800s


Modern Wind Turbines

Windmill and Watermill Energy

Write three wonder statements you have after observing the images of windmills and watermills.

Activity 3

Evaluate Like a Scientist

Quick Code: egs4298

What Do You Already Know About Renewable Energy Resources?

Sources of Energy, Renewable or Not?

The devices you use every day need energy to function. **List** items you have used recently. **Record** the energy source and whether that energy source is renewable or nonrenewable. If you are unsure of the answer, discuss with your class.

Item	Energy Source	Renewable or Nonrenewable

Life Skills I can use information to solve a problem.

What Are Some of the Different Ways We Use Energy from the Sun?

Activity 4

Observe Like a Scientist

Quick Code: egs4299

The Sun

You have studied the sun as a source of **light** and identified it at the beginning of energy chains. Have you ever wondered how the sun produces its light? **Read** the article and **think** about how the sun produces light and **heat**. Then be ready to discuss what you have learned.

The Sun

You have been trying to grow African violets in a pot. Although you remember to water them, they seem droopy. Your mother says, "I think they need more sunlight."

You find a sunny windowsill for your plant. You notice rays of light streaming through the window. It is definitely brighter here. It also feels warmer.

As you think about the sun, you start to realize how important it is. The sun gives us light and warmth. Plants need sunlight to grow. Without the sun, plants could not survive. Animals that eat plants couldn't survive either. Without the sun, life as we know it could not exist on Earth.

The Sun, *continued*

Plants Need Sunlight to Grow

How does the sun make light and heat? The sun is a star. Like all stars, it is made of gases—mostly hydrogen and helium. These gases get so hot that they give off light. The sun's energy comes from reactions between these gases at very high temperatures. These reactions also make large amounts of light and heat. Light and heat travel through space in waves. Some of those waves reach Earth. If you look directly at the sun, its light is so intense that it will damage your eyes. Never look directly at the sun.

A common misconception is that the surface of the sun is solid, like the moon. This is not accurate. The sun is made of gases. It does not have a solid surface. The part that looks like the surface is called the photosphere. It is simply the region of gas on the edge of the sun that gives off light that we can see.

Talk Together Now, talk together about what happens on the sun to produce light. How does sunlight travel to Earth?

Activity 5

Analyze Like a Scientist

Using Energy from the Sun

Quick Code:
egs4300

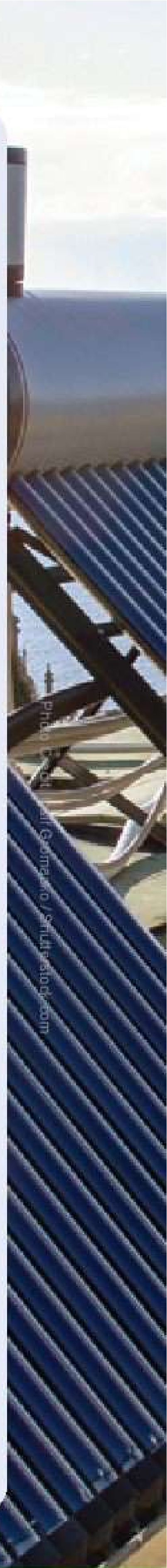
Have you thought about how important the sun is to us? You already know that almost all plants and animals need the sun to survive. Now let's think about how the sun's energy reaches us on Earth and how we use that energy every day. **Read** the text. As you read, **underline** evidence in the text that energy is transformed from one type to another. Then, **draw** a diagram of the sun's energy and how it is transformed.

Using Energy from the Sun

You see and feel sunlight. Even at night when you cannot see the sun in the sky, you feel the warmth of the sun's energy absorbed by the atmosphere. The land and water on Earth's surface also absorb the sun's energy, causing their temperatures to increase. Sunlight is radiant energy, or **radiation**.

Energy received from the sun is called **solar energy**. We can use solar energy as a thermal energy source. Greenhouses allow in light and radiant energy from the sun. This energy converts to heat that warms the inside of the greenhouse. This helps farmers grow crops that would normally only grow in warm climates. Houses, too, can be built in a way that enables the energy from the sun to warm them. This is usually done by placing large glass windows on the wall that faces the sun for the longest part of the day.

Life Skills **I can identify problems.**

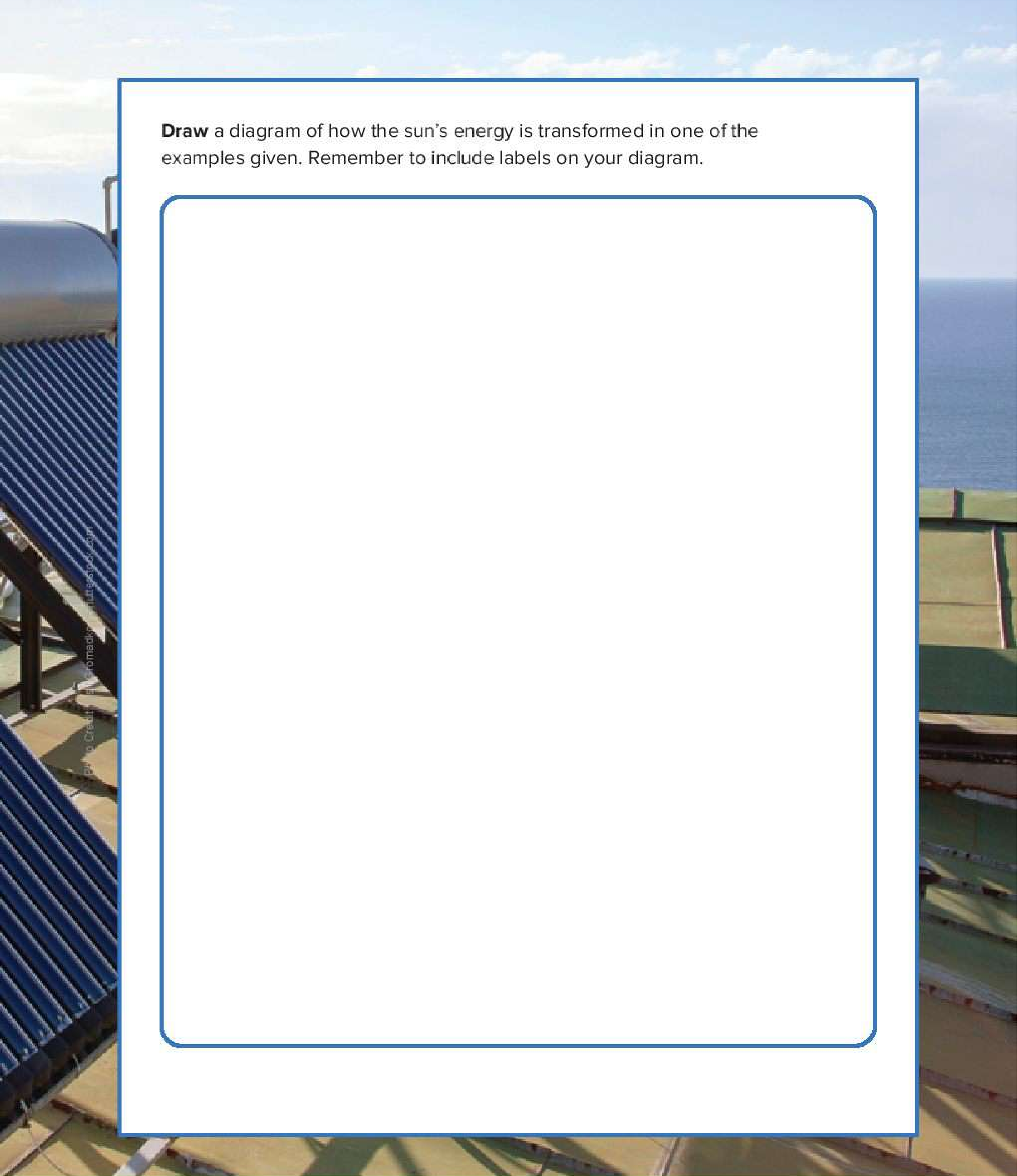


Using Energy from the Sun, *continued*

Solar energy can also be used for cooking. Curved mirrors help in collecting and focusing sunlight to heat a metal pot and cook the food inside.

Solar energy can be used to heat water for other uses, too. Panels made of black pipes can be placed on the roof of a house. As water passes through the pipes, it heats up. It can then be stored in a hot water tank for use.

Solar Water Heater



Draw a diagram of how the sun's energy is transformed in one of the examples given. Remember to include labels on your diagram.

Activity 6

Observe Like a Scientist

Quick Code: egs4301

Solar Energy

Have you seen solar panels in your community? Sometimes they are very small panels and supply energy to only one light. Other times they are very large or in sets that can supply energy to whole buildings or even towns. How might a farmer use solar panels? Look at the images. **Watch** the video and **read** the text. Then, **answer** the questions that follow.

Solar Panels

Solar-Powered Lights

Most solar panels are used to generate electricity. Solar panels that generate electricity are made of many small solar cells. These cells catch the radiant energy of the sun and turn it directly into electricity. This is called solar power.

Life Skills I can identify problems.

The electricity can be used immediately, such as to turn on a streetlight. Or the electricity generated can be stored, such as in a battery. Solar-cell calculators run on batteries powered by small solar cells. Houses and other buildings may use electricity made from rooftop solar panels.

In some villages, solar power is being used to power irrigation equipment. A farmer in Cairo says solar power gives him the energy he needs to run machines that water his plants twice a day.

If the sun's energy is the input of the solar panel system, what is the output of the system?

Which form of energy enters the solar panels? Which form is the energy converted to?

How Can We Capture the Wind to Provide Useful Energy?

Activity 7

Observe Like a Scientist

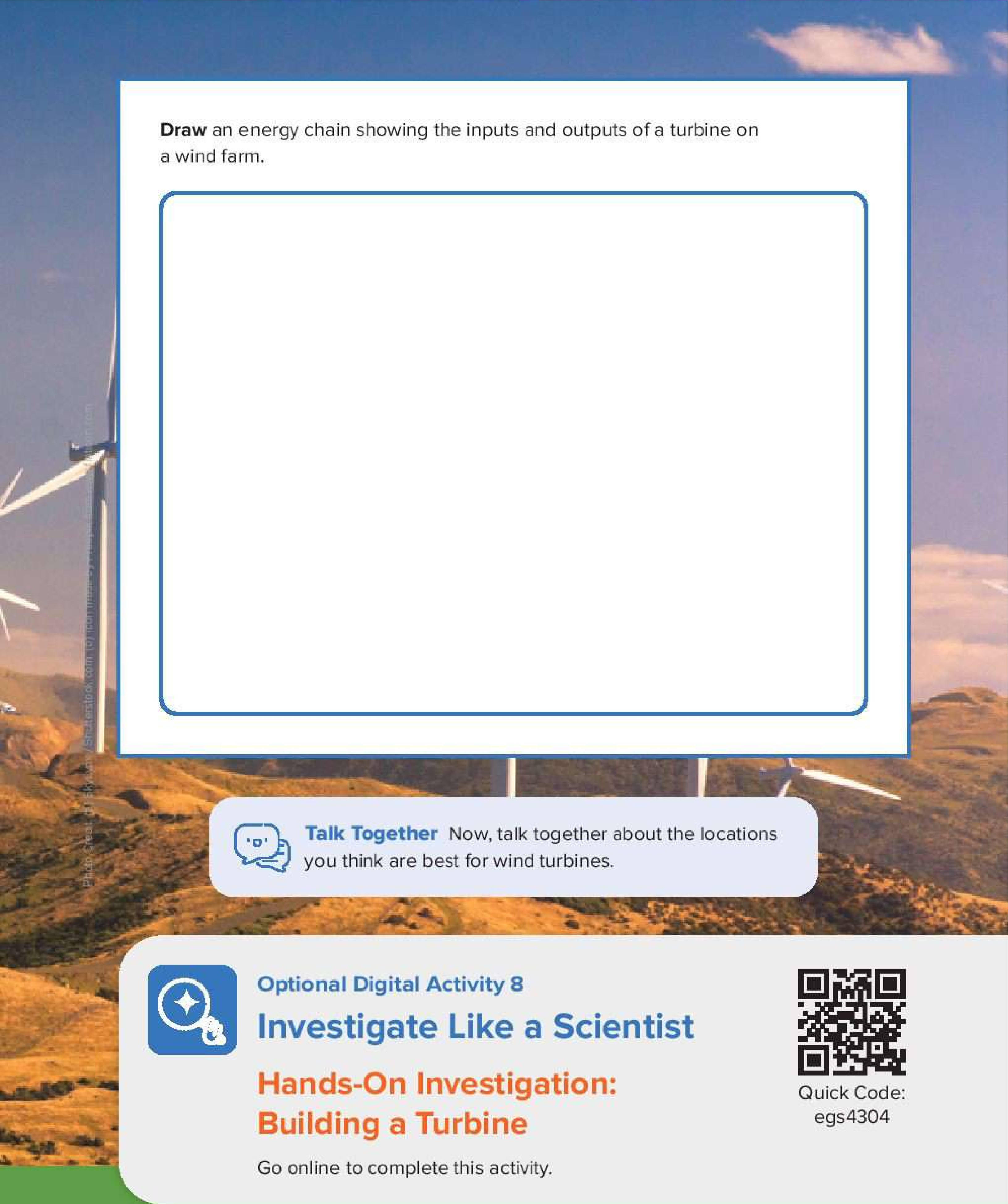
Quick Code:
egs4303

Harness the Wind

The sun is not the only renewable source of energy. How do you think we can use wind as a source of energy? **Read** the text and **watch** the video. **Look** for how wind turbines turn the kinetic energy of wind into electricity. Then, **complete** the activity that follows.

Harness the Wind

As the sun warms Earth, it warms the air. Different parts of the world get different amounts of this solar energy, which causes the air to move and wind to blow. We can use the energy in the wind to turn the blades of windmills. This kinetic energy can be used to generate electrical energy. The electricity from wind turbines is carried by big wires to places where it is needed.



Draw an energy chain showing the inputs and outputs of a turbine on a wind farm.

Talk Together Now, talk together about the locations you think are best for wind turbines.

Optional Digital Activity 8

Investigate Like a Scientist

Hands-On Investigation: Building a Turbine

Go online to complete this activity.

Quick Code: egs4304

How Can Energy from Falling Water Be Used to Generate Electricity?

Activity 9

Analyze Like a Scientist

Quick Code:
egs4305

Falling Water

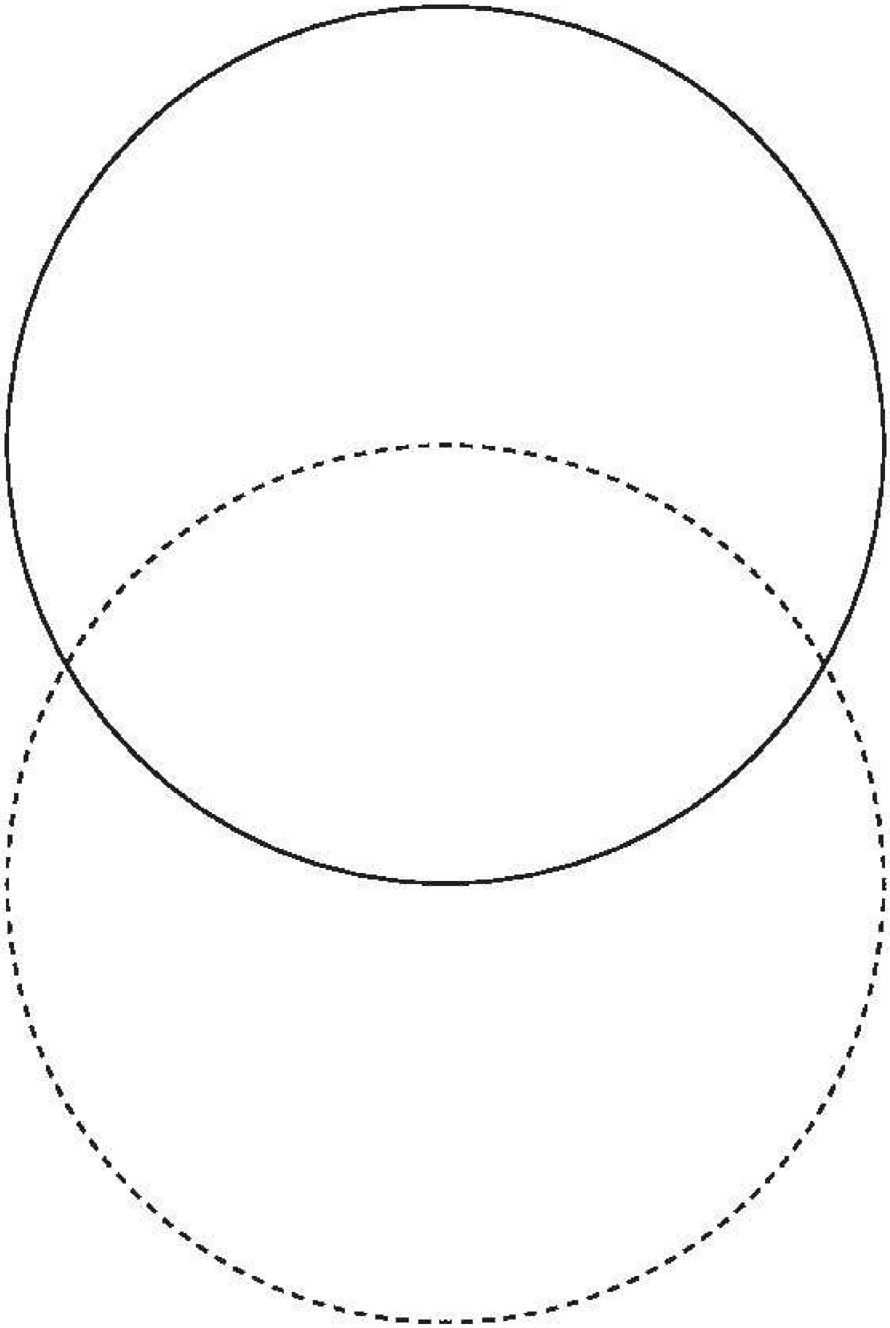
Did you know water can also be used to generate electricity? **Read** the text that follows. As you read, **use** the graphic organizer provided to **record** similarities and differences between using water and using wind to generate electricity.

Falling Water

Hydroelectric Dam

Rivers run downhill. As they run, they change gravitational potential energy to kinetic energy. We can also control the flow of water to generate electricity. A hydroelectric dam holds back the flow of water to build up potential energy. When the water is released, it passes through turbines in the dam. The falling water makes the turbines turn. The turbines and generators in the dam generate electricity. The electricity can be sent along wires to cities where it is needed. This type of electricity is called hydroelectricity.

Using Water to Generate Electricity



Using Wind to Generate Electricity

Activity 10

Investigate Like a Scientist

Quick Code: egs4306

Hands-On Investigation: Modeling a Turbine Generator

How similar do you think wind and water turbines are? In this investigation, you will use a pinwheel to model a spinning **turbine** in a hydroelectric dam. Use what you know about wind turbines to think about how the water system harnesses the flow of energy from water's movement.

What materials do you need? (per group)

- Large bin, at least 4L
- Water
- Pinwheel
- Plastic cup, 250 mL
- Large pitcher, at least 4L

HANDS-ON INVESTIGATION

What Will You Do?

1. Use the materials to model a turbine generator.
2. When the water runs out, use the cup in a way that will make the water a renewable resource within the system.

Think About the Activity

Explain the function of the pinwheel as a model of the hydroelectric power station. Draw a diagram of the model with labels.

Describe how you changed your model so it ran on renewable energy.

How does your solution for providing a renewable resource mimic what happens on Earth? (Hint: consider the water cycle.)

Which alternative energy resources come from forms of mechanical energy?

How can mechanical energy be used to generate electricity?

Activity 11

Record Evidence Like a Scientist

Quick Code: egs4307

Windmills and Watermills

Now that you have learned about renewable energy sources, **look** again at the images you first saw in Wonder.

How can you describe windmills and watermills now?

How is your explanation different from before?

Look at the Can You Explain? question. You first read this question at the beginning of the lesson.

Can You Explain?

What are the different ways we can use renewable energy to generate electricity?

Life Skills **I can review my progress toward a goal.**

Now, use your new ideas to write a scientific explanation to answer this question. First, **write** your claim. Your claim is a one sentence answer to the Can You Explain? question. It should not start with a yes or no.

My claim:

____

____

Next, **record** the evidence that supports your claim. Then, **explain** your reasoning.

Evidence	Reasoning That Supports Claim

Now, write your scientific explanation.

Photo Credit: lovelyday12 / Shutterstock.com

Optional Digital Activity 12

Analyze Like a Scientist

Solar Power in Space

Go online to complete this activity.

Quick Code: egs4308

Optional Digital Activity 13

Evaluate Like a Scientist

Review: Renewable Energy Resources

Go online to complete this activity.

Quick Code: egs4309

Solve Problems Like a Scientist

Unit Project: Dam Impacts

Quick Code: egs4344

Throughout Energy and Fuels, you have learned about how humans use Earth's resources to power our lives. You know that there are advantages and disadvantages to using both renewable and nonrenewable sources of energy.

The image shown is a picture of a dam. You might have seen dams in your local community. In this project, you will learn about plans to build a dam on the Zambezi River of Zimbabwe, in the Batoka River Gorge. You will analyze the effects of building a dam for the purpose of generating hydroelectric power. You will be asked to consider how communities of people, ecosystems, and the landscape may be affected, both positively and negatively. **Read** the text and **complete** the activities that follow.

Kariba Dam

Life Skills **I can decide on a solution to use.**

Dam Impacts

Perhaps you have seen a large dam in your local community. One large dam, the Kariba Dam, is located on the border area between Zambia and Zimbabwe, in the southern part of Africa. This dam holds back the world's largest reservoir and has faced various challenges since the 1950s, when it was built.

The river the dam is built on is home to one of the world's largest waterfalls, called Victoria Falls. Victoria Falls is an incredibly powerful waterfall and provides a unique habitat for various living organisms.

Dams are designed to harness the kinetic energy of moving water and use this energy to spin the turbines to generate electricity. Kariba Dam was created to control the water flow at Victoria Falls and use it to generate electricity that can power homes and businesses. However, dams also affect the environment that surrounds them. How do dams change the landscape? How does building a dam affect humans and wildlife that depend on the river?

Photo Credit: Maksim Safaniuk / Shutterstock.com

Dam Impacts, *continued*

Let's get to know the impact of building dams through studying what happens as a result of building Kariba Dam. The Batoka River Gorge is a deep and narrow canyon that begins just below Victoria Falls. Tourists come to ride the whitewater rapids of the Zambezi River and admire the landscape. The gorge is a World Heritage Site because of its beauty, the fact that it is home to a variety of endangered animals, and the two million years of geology witnessed in the canyon walls. Normally, this designation means that a place cannot be disturbed. However, this is the proposed site of the Batoka River Hydroelectric Power Plant.

So why do some support building a dam that would flood this area? Less than half of the people in Zimbabwe have access to electricity. Even those who have electric power sometimes face outages that can last for many days. Fewer and fewer people are able to pay for electricity. The limited supply of power means the price of energy has become more expensive. People who support construction of the dam say that hydroelectric power is the answer to these problems.

In this project, you will investigate both the positive and negative impacts of building a dam.

You will be asked to consider both advantages and drawbacks, as well as conduct research to come up with solutions to the problems associated with hydroelectric power plants.

Positive or Negative?

Think about the potential impacts of building a dam in the Batoka River Gorge. Which of the following effects of creating a dam are positive, and which are negative? **Complete** the graphic organizer with the effects listed.

- changing fish migration routes
- flooding a habitat area of an endangered species
- producing hydroelectric power
- controlling the downstream river level
- providing a steady water supply

Positive	Negative

Unit Project

Energy Transfer at the Batoka River Gorge Dam

Supporters of the proposed dam in the Batoka River Gorge claim that the hydroelectric power plant would produce thousands of hours of electrical power for people who do not currently have access. How would a hydroelectric power plant solve this problem? **Create** an energy model showing the energy transformations from water to electrical energy.

Photo Credit: Maksim Safaniuk / Shutterstock.com

Advantages and Disadvantages

In the next two sections, you will be asked to conduct research on the construction of dams. **Decide** what you think is the greatest benefit of building a dam for hydroelectric power. Then, **think** about the major drawbacks. Be sure to **list** all sources you use to research your answers.

The Greatest Benefit

Choose the greatest benefit of building a hydroelectric power dam and **research** it. Then, **explain** why you chose that benefit as the best for communities of people, ecosystems, and the landscape surrounding a dam.

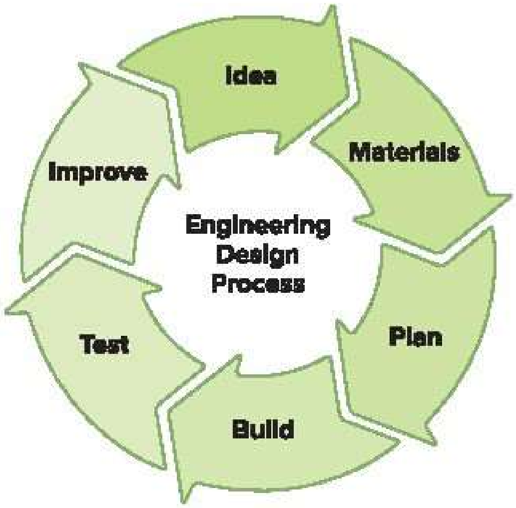
Disadvantages and Solutions

Choose one of the drawbacks of building a dam for hydroelectric power. Now, **research** possible solutions to that problem. **Write** a description of why it is important to address this problem, and then propose a solution.

Interdisciplinary Project: Sunny Side Up

Quick Code: egs4431

In this interdisciplinary project, you will use your science and math skills to find a solution to a real-world problem. First, you will read a story about a fictional group of characters, called the STEM Solution Seekers. Then, you will study some background information, and you will design, test, and refine a solution to the overall challenge. You will go through the steps of the Engineering Design Process, as shown in the diagram. You will also do some additional work in your math class related to this challenge.



The project *Sunny Side Up* challenges you to think about the impact of deforestation and how humans can use solar energy as a clean, renewable resource. In the story, you will read about a problem that a STEM Solution Seeker is having while trying to collect firewood to use as fuel for cooking. You will learn more about solar energy, and then you will design a solar cooker of your own to help find a solution.

Sunny Side Up

Jin, Claudia, Michael, and Hala are visiting Nadine, who lives in a village near Ngaoundere, Cameroon. They are all members of an international science fair team and usually work together over video calls. They are excited to be able to meet each other in person.

"Cameroon is so cool," says Michael as they walk along a dirt road in Nadine's village. "It is not like Washington, D.C., at all."

"It is much greener than Egypt," says Hala, "and there is no sea nearby."

As the five continue to walk toward Nadine's home, they begin to talk about their latest projects for the science fair. Claudia says, "Nadine, didn't you say you wanted help with some kind of a robot?"

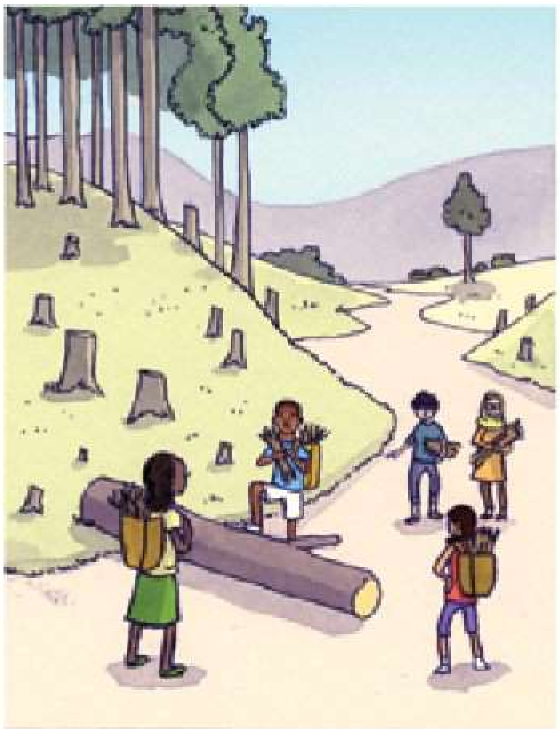
"Well, yes," Nadine replies, "I want to create a robot to help me gather wood for my mom's cooking fire."

When they arrive at Nadine's home, they are welcomed warmly and almost immediately served a traditional meal of meat sauce, millet, and vegetables, which they enjoy while getting to know Nadine's family.

The next morning, Nadine and her friends go out to gather firewood for her family's cooking fire. They have been walking a long time when Jin says, "Is it much farther? I am getting tired."

"Me too!" Michael, Claudia, and Hala all agree.

"Just a little farther, and then we can fill our baskets," Nadine encourages them. "You can see why a robot would be nice. I do this every day. The wood used to be closer, but people have been cutting more and more of the forest down and we have to walk farther and farther to find wood."



"That happens where I live in Peru too" Claudia says. "Not only is this tough on people who rely on the lumber to survive, but it also harms the plants and animals that make the forest their home. Deforestation could destroy the habitat of some species for good," she adds.

After a few more minutes, Hala says, "I do not think you need a robot, Nadine. You would still be taking more wood out of the forest. I think you need a different kind of fuel for your fire."

Nadine considers and says, "People with more money sometimes use gas or kerosene for cooking, but they have to buy it at the store. Most families cannot afford that."

"I like the idea of finding another fuel for cooking, Nadine," Michael says. "It looks like your forest is not going to be here very long at this rate."

“I bet you could use a solar cooker here,” Jin says excitedly. “It is nice and sunny.”

Hala says, “Some people in the deserts of Egypt use them. I think they call them sun stoves.”

“I do not know how to make one, but I bet we could figure it out,” suggests Michael.

“Oooooh, I know what we can do!” Jin is so excited by his new idea that he drops all of his wood. “When we get back, I can draw a model of what I am thinking.”

They start planning as they load up their baskets and carry the wood back to Nadine’s house.

At dinner, Nadine’s mother likes the idea of a solar cooker since it would be far less messy than using fire, but worries that it would not cook the food enough. The next morning, the friends all work together on their plans for a solar cooker. They also begin to wonder, *how could we figure out if there is enough sunlight to power a solar cooker?*

Deforestation and Solar Energy

Cooking is one main reason that there is a demand for wood fuel and is a major cause of deforestation. Deforestation is not only a problem for Nadine's village in Cameroon; it affects many places all over the world.

Deforestation is the clearing of trees in forests by humans. There are many beautiful plants and unique animal species that can only be found in certain rain forests. Sadly, the deforestation of rainforests around the world for fuel is partly responsible for a decrease in animal habitats and loss of plants that could be used for medicines.

One alternative to using firewood for cooking fuel is the use of solar energy. Solar energy is energy from the sun. Most solar energy is reflected off or absorbed by Earth's surface and atmosphere.

Solar energy is free, renewable, clean, and saves trees, but there are some drawbacks to relying on this type of energy.

The equipment needed to collect and use solar energy can be expensive. Also, the amount of sunlight that hits Earth's surface is not the same all the time and varies widely from place to place. How much sunlight an area receives depends on factors such as distance from the equator, time of day, and season.

One type of tool powered by solar energy is a solar cooker. Solar cookers absorb light energy like solar panels do, but they convert solar energy into thermal energy (instead of electricity) to create heat in the cooker. Solar cookers often have metal panels carefully positioned to collect as much light as possible and direct the light to one concentrated area. The heat generated through this process must be kept, or trapped, within the oven long enough for raw food to be cooked to a safe temperature for eating. Solar cookers come in a variety of shapes and designs.

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Hands-On Investigation

Engineering Your Solution

Challenge

You have been asked to create a solar cooker that can heat food to a safe temperature (71°C). This activity will guide your team through the Engineering Design Process.

Objectives

In this activity, you will . . .

- Review the challenge requirements and assign roles to each member of your team.
- Create three or four sketches to brainstorm solutions.
- Agree on one final blueprint for your prototype.
- Build a solar cooker that uses energy from the sun to cook food to a temperature of at least 71°C.

A Solar Cooker

What materials do you need? (per group)

- Poster board or construction paper for final blueprint
- Building materials, such as a cardboard box, ruler, aluminum foil, plastic wrap, black paper
- Construction materials, such as tape, glue, scissors
- Testing materials, such as a thermometer, clock

HANDS-ON INVESTIGATION

Procedure

Follow these steps with your teammates:

1. **Review the Challenge** Study the challenge and design requirements for this project.
2. **Assign Group Roles** Decide the roles for the members of your group and record the names next to each role.
3. **Sketch Ideas** Review the materials data tables with your teammates and begin brainstorming. As a team, select three or four ideas to plan out in the Sketching Our Design boxes. Review your sketches and decide on one design to fully develop. Add more details to make it your blueprint that you will use to help you create your solution.
4. **Plan and Build** Gather materials and begin building your prototype. Make sure to keep track of your steps and process.
5. **Test** Once your prototype is finished, establish which materials you will need for testing. Discuss how you will measure the effectiveness of your design. Conduct your test according to your teacher's directions.
6. **Reflect and Present** When finished, review your product and your process. Identify ways you could improve. Prepare to share with your class.

Life Skills **I can review expectations.**

Group Roles

Roles	Student name
Team Captain Provide encouragement and support; help other team members with their roles if needed; keep track of timeline	
Materials Manager Gather and organize materials; request additional materials if needed	
Chief Engineer Coordinate building the model; suggest when a test may be needed; make sure the team is building safely	
Team Reporter Record all steps of the process; share the process the team went through to complete the challenge	

Design Requirements

- [ ] Your solution must include a diagram and a prototype of your solar cooker, as well as a presentation sharing both your prototype (product) and how you worked together as a team (process).
- [ ] Your solution can only use materials your teacher has available and your design should be based on the data shared in the tables that follow.

Testing Data

In order to maximize energy from the sun, consider the following three tasks of your solar cooker: How could you best **reflect** and direct the sunlight, **absorb** its heat, and **trap** that heat inside the solar cooker?

Review the following data tables to study how different materials affected the temperature that a cup of water can be heated to in the sunlight. Consider this information when choosing the materials and the design of your solar cooker.

Test 1: Reflecting Sunlight
The following test was applied to investigate the best material for the reflecting panels of a solar cooker.

	Aluminum Foil Panel	Red Construction Paper Panel	Cardboard Panel
Temperature of water after 20 minutes in sunlight	42°C	22°C	20°C

Test 2: Converting Sunlight
The following test was applied to determine the best way to convert sunlight to heat through absorption.

	Cup covered in black construction paper	Cup covered in light colored fabric	Clear cup
Temperature of water after 20 minutes in sunlight	40°C	35°C	30°C

Test 3: Trapping Sunlight
The following test was applied to determine the best way to trap heat inside of a cup of water.

	Clear cup	Cup covered in fabric	Cup covered in plastic wrap
Temperature of water after 20 minutes in sunlight	22°C	23°C	25°C

Sketching Our Design

With your team, discuss these two questions for your ideas: What do you like about these ideas? Where can you make improvements to the designs? Circle your final design to create.

Life Skills **I can use information to solve a problem.**

Plan, Build, and Test

STEP 1 Now that you have selected one design idea, create a separate diagram with additional details that you will share during your presentation. This detailed diagram is the blueprint for your prototype. Identify any materials that you will use on the detailed diagram. Show what your solar cooker will look like from the side view, the top view, and any other views you think are needed. Color code your team's blueprint to make sure you have the necessary working parts of a solar cooker with the following:

- In yellow, outline the part that directs the sunlight.
- In orange, outline the part that absorbs the sunlight.
- In red, outline the part that traps the heat.

STEP 2 Gather the materials you identified in your blueprint. You may need to make adjustments to these materials as you are building. Keep track of what you actually use.

STEP 3 Begin building your prototype. As you build, you may run into problems or challenges. Focus on one problem at a time and use your group's creativity and collaboration skills to find solutions. Engineers use notebooks and documentation to troubleshoot when things go wrong so that they can look for places to make improvements.

STEP 4 Test your solar cooker prototype. Leave the solar cooker outside on a sunny day for 30 minutes, or longer if necessary. Place a thermometer inside the solar cooker to measure the temperature inside. Make sure your solar cooker reaches a temperature of at least 71°C. Record the temperature and the time it took for your solar cooker to reach the temperature in your notes.

STEP 5 Once your prototype is complete, work with your team to create a presentation to share both your product and your process. Be sure to explain the parts of your prototype that direct, absorb, and trap sunlight. Also, prepare to share how your team worked together, if you encountered any problems, and how you worked to make improvements.

Life Skills **I can decide on a solution to use.**

Advanced Learners: Writing Opportunity

Are you ready for a challenge? If time allows, write a set of directions for assembling your solar cooker and create an Assembly Instructions pamphlet. Add drawings with labels to clarify each step. Remember that your audience is people who have not used a solar cooker before and are accustomed to using wood as fuel.

Presentation Notes

Analysis and Conclusions

Reflect on the following questions:

1. Did you and your group encounter any problems as you assembled and used your solar cooker? If so, how did you solve those problems?

2. Did your solar cooker perform as well as you expected? If not, what might explain this?

3. What improvements would you make to the design process or to your final prototype?

4. What was your role on the team? What did you do well? What improvements could you make?

Primary 4 Resources

- Safety in the Science Classroom
- Glossary

Safety in the Science Classroom

Following common safety practices is the first rule of any laboratory or field scientific investigation.

Dress for Safety

One of the most important steps in conducting a safe investigation is dressing appropriately.

- Use gloves to protect your hands and safety goggles to protect your eyes when handling chemicals, liquids, or organisms.
- Wear proper clothing and clothing protection. Tie back long hair, roll up long sleeves, and if they are available, wear a lab coat or apron over your clothes. Always wear close-toed shoes. During field investigations, wear long pants and long sleeves.

Be Prepared for Accidents

Even if you are practicing safe behavior during an investigation, accidents can happen. Learn the emergency equipment location if available and how to use it.

Most importantly, when an accident occurs, immediately alert your teacher and classmates. Do not try to keep the accident a secret or respond to it by yourself. Your teacher and classmates can help you.

Practice Safe Behavior


Safety Goggles

There are many ways to stay safe during a scientific investigation. You should always use safe and appropriate behavior before, during, and after your investigation.

- Read all of the steps of the procedure before beginning your investigation. Make sure you understand all the steps. Ask your teacher for help if you do not understand any part of the procedure.
- Gather all your materials and keep your workstation neat and organized. Label any chemicals you are using.
- During the investigation, be sure to follow the steps of the procedure exactly. Use only directions and materials that have been approved by your teacher.
- Eating and drinking are not allowed during an investigation. If asked to observe the odor of a substance, do so using the correct procedure known as wafting, in which you cup your hand over the container holding the substance and gently wave enough air toward your face to make sense of the smell.
- When performing investigations, stay focused on the steps of the procedure and your behavior during the investigation. During investigations, there are many materials and equipment that can cause injuries.
- Treat animals and plants with respect during an investigation.
- After the investigation is over, appropriately dispose of or store any materials that you have used. Ask your teacher if you are unsure of how to dispose of anything.
- Make sure that you have returned any extra materials and pieces of equipment to the correct storage space.
- Leave your workstation clean and neat. Wash your hands thoroughly.

A

adaptation
a behavior or physical feature that has changed over time to help an organism survive in its environment (related word: adapt)

antenna
a device that receives radio waves and television signals

Arctic
being from an icy climate, such as the north pole

B

behavior
all of the actions and reactions of an animal or a person (related word: behave)

brain
the main control center in an animal body; part of the central nervous system

C

camouflage
the coloring or patterns on an animal's body that allow it to blend in with its environment

canyons
deep valleys carved by flowing water

chemical energy
energy that can be changed into motion and heat

chemical weathering
changes to rocks and minerals on Earth's surface that are caused by chemical reactions

code
information transformed into another, representative, form (such as using dots and dashes to represent letters)

collision
the moment where two objects hit or make contact in a forceful way

convert (v)
to change forms

D

delta
a fan-shaped mass of mud and other sediment that forms where a river enters a large body of water

deposition
laying sediment back down after erosion moves it around

digestive system
the body system that breaks down food into tiny pieces so that the body's cells can use it for energy

digital
a signal that is not continuous and is made up of tiny separate pieces

dune
a hill of sand created by the wind

E

Earth
the third planet from the sun; the planet on which we live (related words: earthly; earth – meaning soil or dirt)

earthquake
a sudden shaking of the ground caused by the movement of rock underground

electromagnetic spectrum
the full range of frequencies of electromagnetic waves

energy
the ability to do work or cause change; the ability to move an object some distance

energy conservation
to use energy wisely in order to prevent the wasteful overuse of resources

energy efficiency
reducing the amount of energy needed to perform a task

energy source
where a form of energy begins

energy transfer
the transfer of energy from one organism to another through a food chain or web; or the transfer of energy from one object to another, such as heat energy

engineer
Engineers have special skills. They design tools or technologies that help solve problems.

erosion
the removal of weathered rock material. After rocks have been broken down, the small particles are transported to other locations by wind, water, ice, and gravity.

erupt
the action of lava coming out of a hole or crack in Earth's surface; the sudden release of hot gasses or lava built up inside a volcano (related word: eruption)

extinct
describes a species of animals that once lived on Earth but which no longer exists (related word: extinction)

F

feature
things that describe what something looks like

force
a pull or push that is applied to an object

forecast
(v) to analyze weather data and make an educated guess about weather in the future; (n) a prediction about what the weather will be like in the future based on weather data

fossil fuels
fuels that come from very old life forms that decomposed over a long period of time, like coal, oil, and natural gas

friction
a force that slows down or stops motion fuel

fuels
any materials that can be used for energy

G

generate
to produce by turning a form of energy into electricity

geothermal
heat found deep within Earth

glacier
a large sheet of ice or snow that moves slowly over Earth's surface

gravitational potential energy
energy stored in an object based on its height and mass

H

heart
the muscular organ of an animal that pumps blood throughout the body

heat
the transfer of thermal energy

hibernate
to reduce body movement during the winter in an effort to conserve energy (related word: hibernation)

I

information
facts or data about something; the arrangement or sequence of facts or data

K

kinetic energy
the energy an object has because of its motion

L

lava
molten rock that comes through holes or cracks in Earth's crust that may be a mixture of liquid and gas but will turn into solid rock once cooled

light
a form of energy that moves in waves and particles and can be seen

M

magma
melted rock located beneath Earth's surface

magnetic field
a region in space near a magnet or electric current in which magnetic forces can be detected

mass
the amount of matter in an object

matter
material that has mass and takes up some amount of space

mechanical weathering
breaking down of rocks due to physical factors (as opposed to chemical factors)

migration
the movement of a group of organisms from one place to another, usually due to a change in seasons

minerals
natural, nonliving solid element that makes up rocks

model
a drawing, object, or idea that represents a real event, object, or process

motion
when something moves from one place to another (related words: move, movement)

N

nerve
a cell of the nervous system that carries signals to the body from the brain, and from the body to the brain and/or spinal cord

nonrenewable
once it is used, it cannot be made or reused again

nonrenewable resource
a natural resource of which a finite amount exists, or one that cannot be replaced with currently available technologies

O

ocean
a large body of salt water that covers most of Earth

opaque
describes an object that light cannot travel through

organism
any individual living thing

P

pollute
to put harmful materials into the air, water, or soil (related words: pollution, pollutant)

pollution
when harmful materials have been put into the air, water, or soil (related word: pollute)

potential energy
the amount of energy that is stored in an object; energy that an object has because of its position relative to other objects

predator
an animal that hunts and eats another animal

predict
to guess what will happen in the future (related word: prediction)

prey
an animal that is hunted and eaten by another animal

pupil
the black circle at the center of an iris that controls how much light enters the eye

R

radiation
electromagnetic energy (related word: radiate)

receptor
nerves located in different parts of the body that are especially adapted to receive information from the environment

reflect
light bouncing off a surface (related word: reflection)

reflex
an automatic response

renewable
to reuse or make new again

renewable resource
a natural resource that can be replaced

reproduce
to make more of a species; to have offspring (related word: reproduction)

resistance
when materials do not let energy transfer through them

rock cycle
the process during which rocks are formed, change, wear down, and are formed again over long periods of time

S

sediment
solid material, moved by wind and water, that settles on the surface of land or the bottom of a body of water

seismic
having to do with earthquakes or earth vibrations

senses
taste, touch, sight, smell, and hearing (related word: sensory)

soil
the outer layer of Earth's crust in which plants can grow; made of bits of dead plant and animal material as well as bits of rocks and minerals

sound
anything you can hear that travels by making vibrations in air, water, and solids

sound wave
a sound vibration as it is passing through a material; most sound waves spread out in every direction from their source

speed
the measurement of how fast an object is moving

stomach
a muscular organ in the body where chemical and mechanical digestion take place

sun
any star around which planets revolve

survive
to continue living or existing: an organism survives until it dies; a species survives until it becomes extinct (related word: survival)

system
a group of related objects that work together to perform a function

T

tectonic plate
one of several huge pieces of Earth's crust

thermal energy
energy in the form of heat

trait
a characteristic or property of an organism

transparent
describes materials through which light can travel; materials that can be seen through

turbine
a machine designed to spin in a stream of moving water, steam, or wind that is often used in generating electricity

V

valley
a low area of land between two higher areas, often formed by water

volcano
an opening in Earth's surface through which magma and gases or only gases erupt (related word: volcanic)

W

water
a compound made of hydrogen and oxygen; can be in either a liquid, ice, or vapor form and has no taste or smell

watermills
structures that use a turbine or water wheel to harness the kinetic energy of moving water to operate machinery or as a step in the generation of electricity

wave
a disturbance caused by a vibration; waves travel away from the source that makes them

weathering
the physical or chemical breakdown of rocks and minerals into smaller pieces or aqueous solutions on Earth's surface

windmills
structures that use blades placed at an angle around a fixed point to convert the kinetic energy of wind into energy that can operate machinery or generate electricity

work
a force applied to an object over a distance

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